Imnaha River Spring/Summer Chinook Salmon Hatchery Program Review

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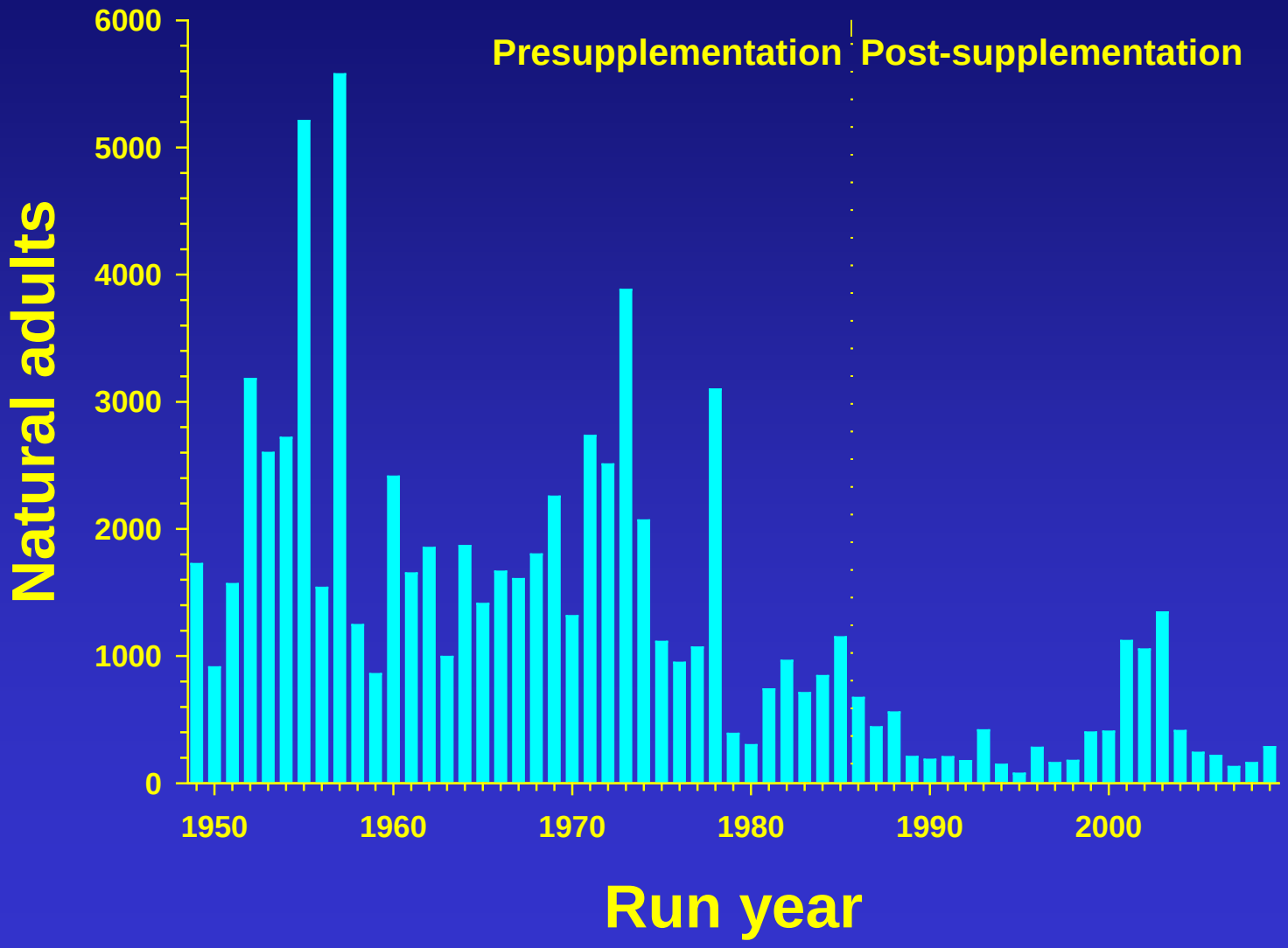
Presentation Outline

- Management objectives and compensation/production goals
- Monitoring and evaluation objectives and methods
- Broodstock development and management strategies
- In - hatchery production performance
- Hatchery program performance – survival, adult returns, catch and escapement and fishery restoration
- Supplementation effectiveness
- Conclusions and future challenges

Natural Adult Abundance



Mitigation Goals

Imnaha River Spring/Summer Chinook Salmon Annual Goals

490,000 Smolts (360,000 interim)

24,500 Lbs.

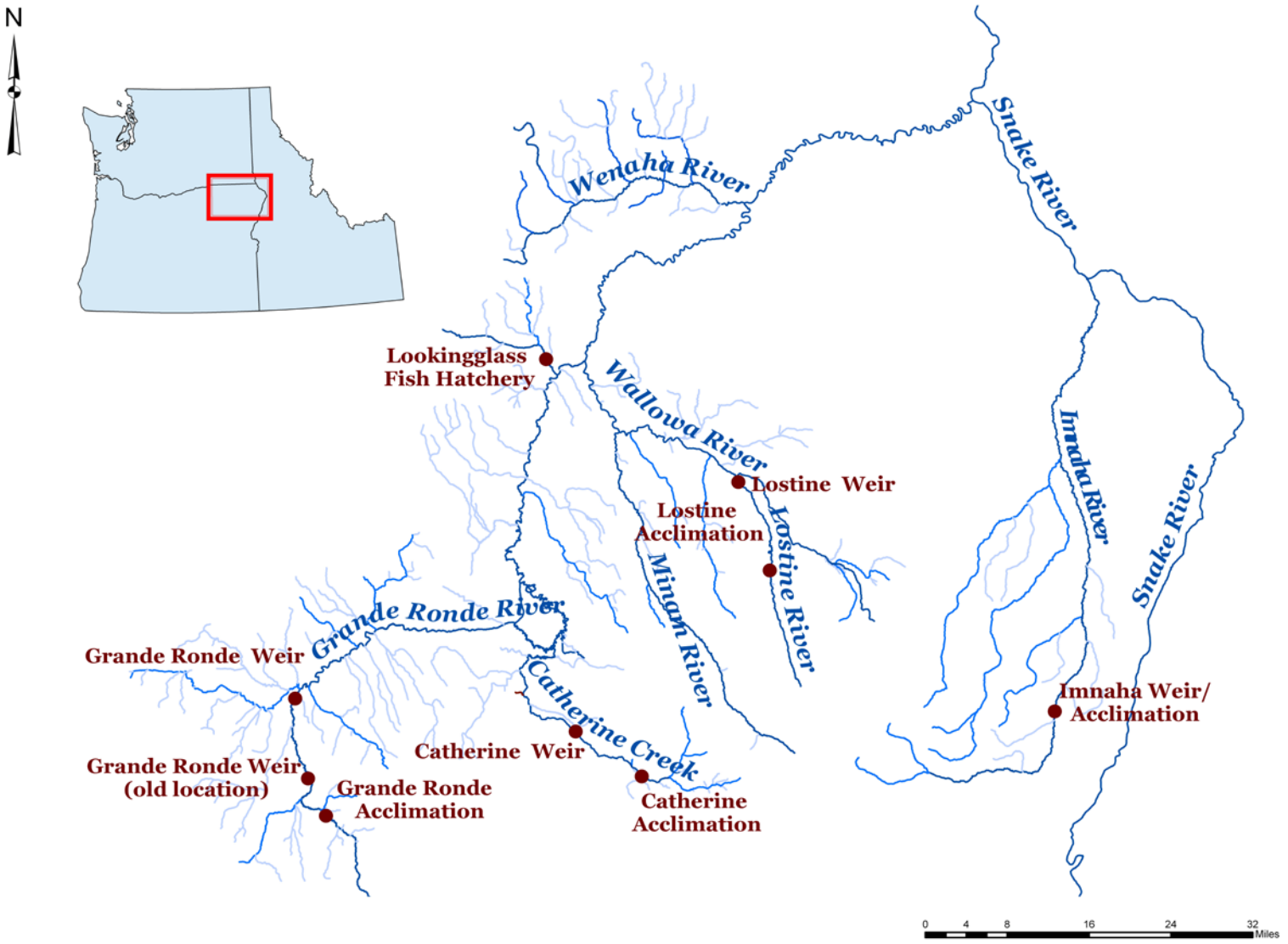
3,210 Adults

0.65% Smolt-to-Adult Return Rate

16,050 Total Adults

3.25% Smolt-to-Adult Survival Rate

Grande Ronde and Imnaha River Basins Chinook Hatchery Facilities



Management Objectives

- Establish an annual supply of broodstock capable of meeting production goals.
- Maintain and enhance natural production while maintaining long term fitness of the natural population.
- Re-establish historic tribal and recreational fisheries.
- Establish a total return number of spring chinook salmon that meets the LSRCP compensation goal.
- Operate the hatchery program so we maintain the genetic and life history characteristics of the natural population and hatchery fish characteristics mimic those of the wild fish, while achieving management objectives.

Monitoring and Evaluation Objectives

- Document and assess fish culture and hatchery operation practices and performance.
- Determine optimum rearing and release strategies that will produce maximum survival to adult.
- Determine total catch and escapement, smolt survival, smolt-to-adult survival, and assess if adult production meets mitigation goals.
- Assess and compare recruits-per-spawner of hatchery and natural origin fish.
- Assess response in natural population abundance and productivity (adult recruits-per-spawner, smolts-per-spawner) to supplementation.
- Assess and compare life history characteristics (age structure, run timing, sex ratios, smolt migration, fecundity) of hatchery and natural fish.
- Assess success in restoring fisheries.

Lookingglass Hatchery

Imnaha Sliding Scale Management Plan

Escapement Level	Maximum % Natural Retained for Broodstock	% Hatchery Above Weir	Minimum % of Natural Origin Broodstock
>15	0	NA	NA
15-159	50	NA	NA
150-299	40	70	20
300-499	40	60	25
500-999	30/40*	50	30
1000-1499	30/40*	40/30*	40
1500-1999	25	25	50
>2000	25	<10*	100

* 3 consecutive years with Minimum Abundance Threshold $\geq$ 1000

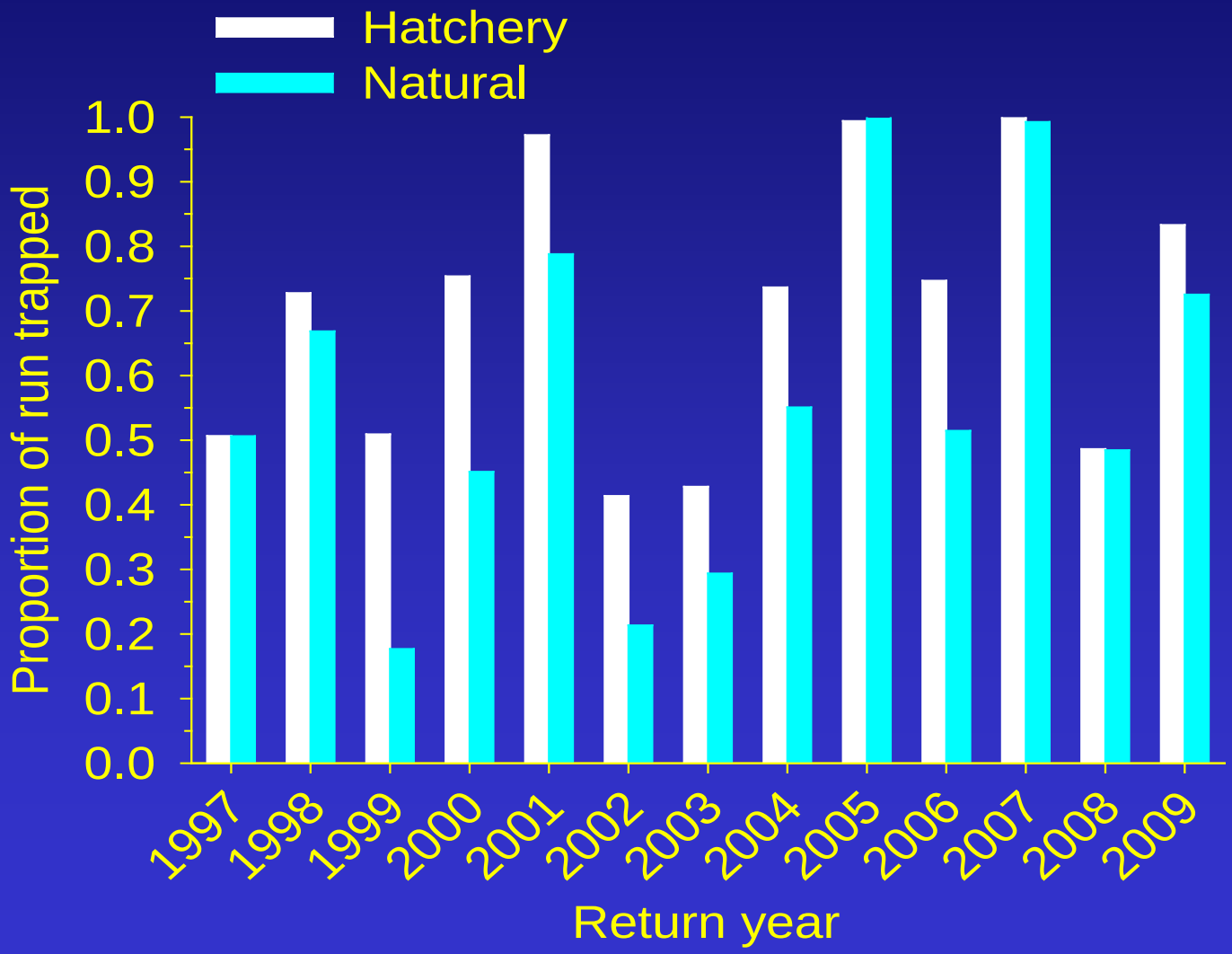
Broodstock History – Imnaha River

Spawn years	Number of females in broodstock		Percent natural origin adults in broodstock
	Natural	Hatchery	
1982-1988	10-91	0-10	100-82.2
1989-2002	6-48	9-168	7.1-71.4
2003-2009	19-34	72-87	19.1-26.4

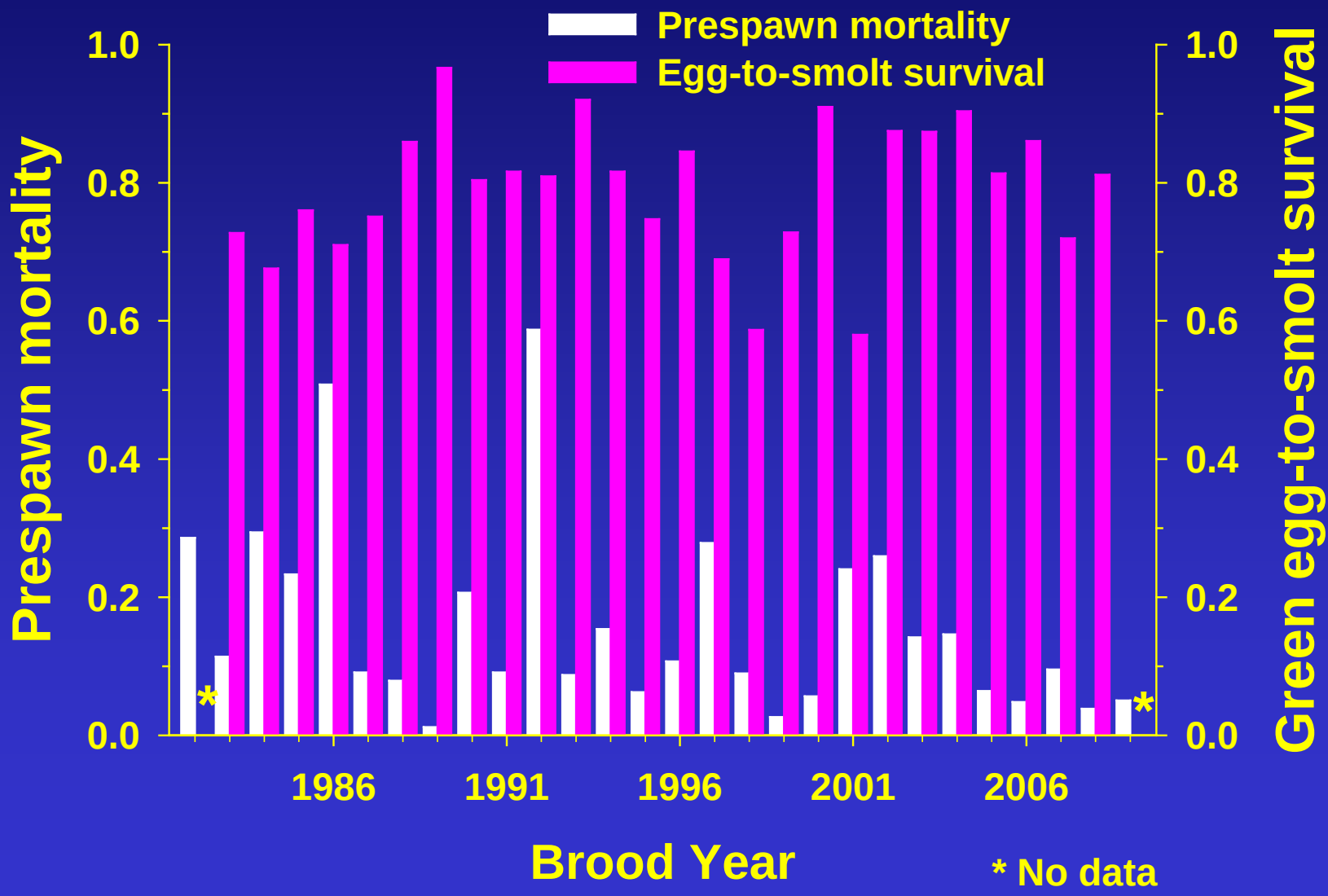
Natural Spawners – Imnaha River

Spawn year	Total Number spawning in nature	Percent hatchery spawning in nature	Percent natural retained for broodstock	PNI
1982-1988	539-1715	0-15.4	2.3-28.8	1-0.842
1989-2002	291-4643	24.4-75.8	3.0-28.9	0.125-0.746
2003-2009	804-3164	49.3-86.2	3.9-21.2	0.218-0.279

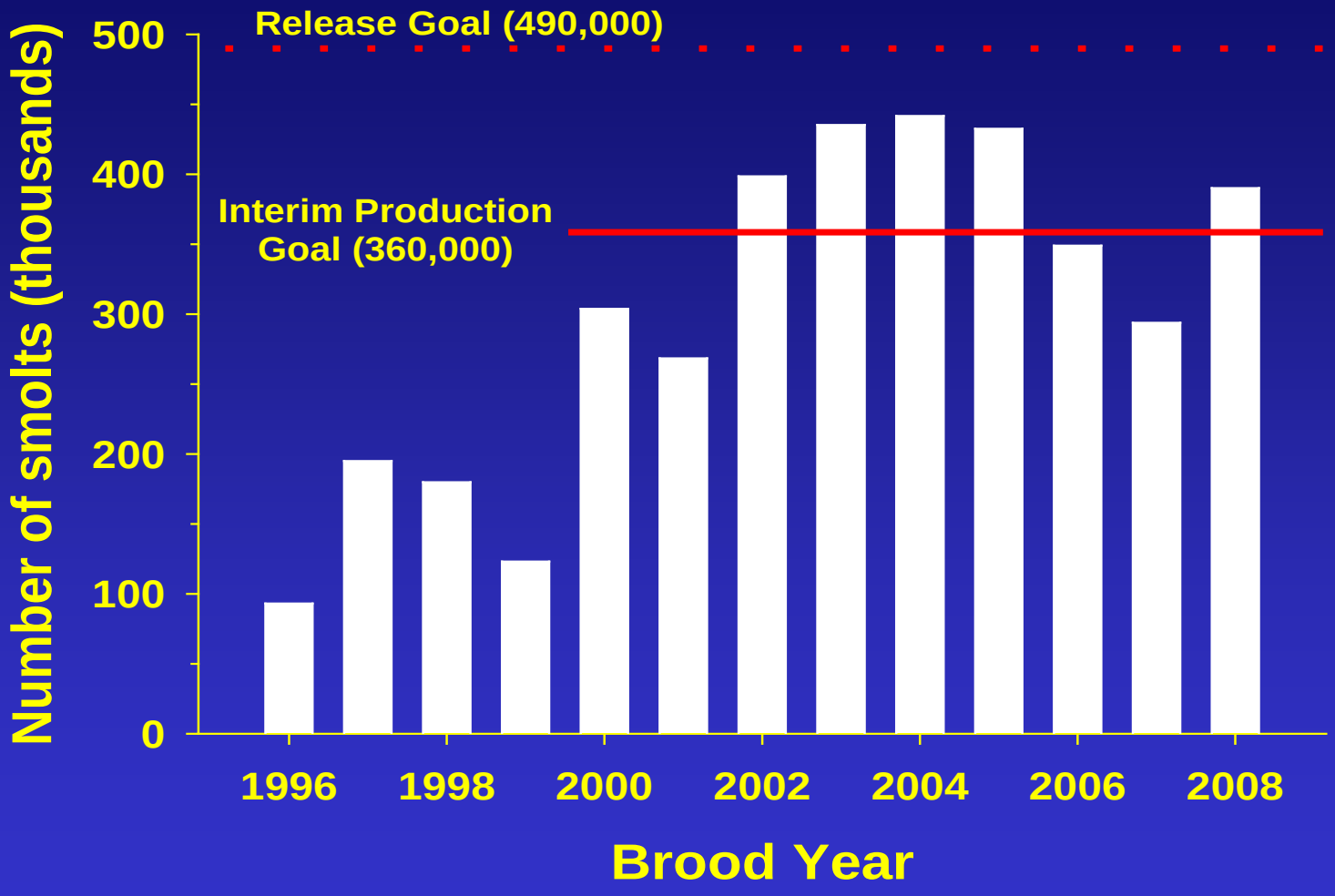
Proportion of Chinook Run Trapped at Imnaha River Weir



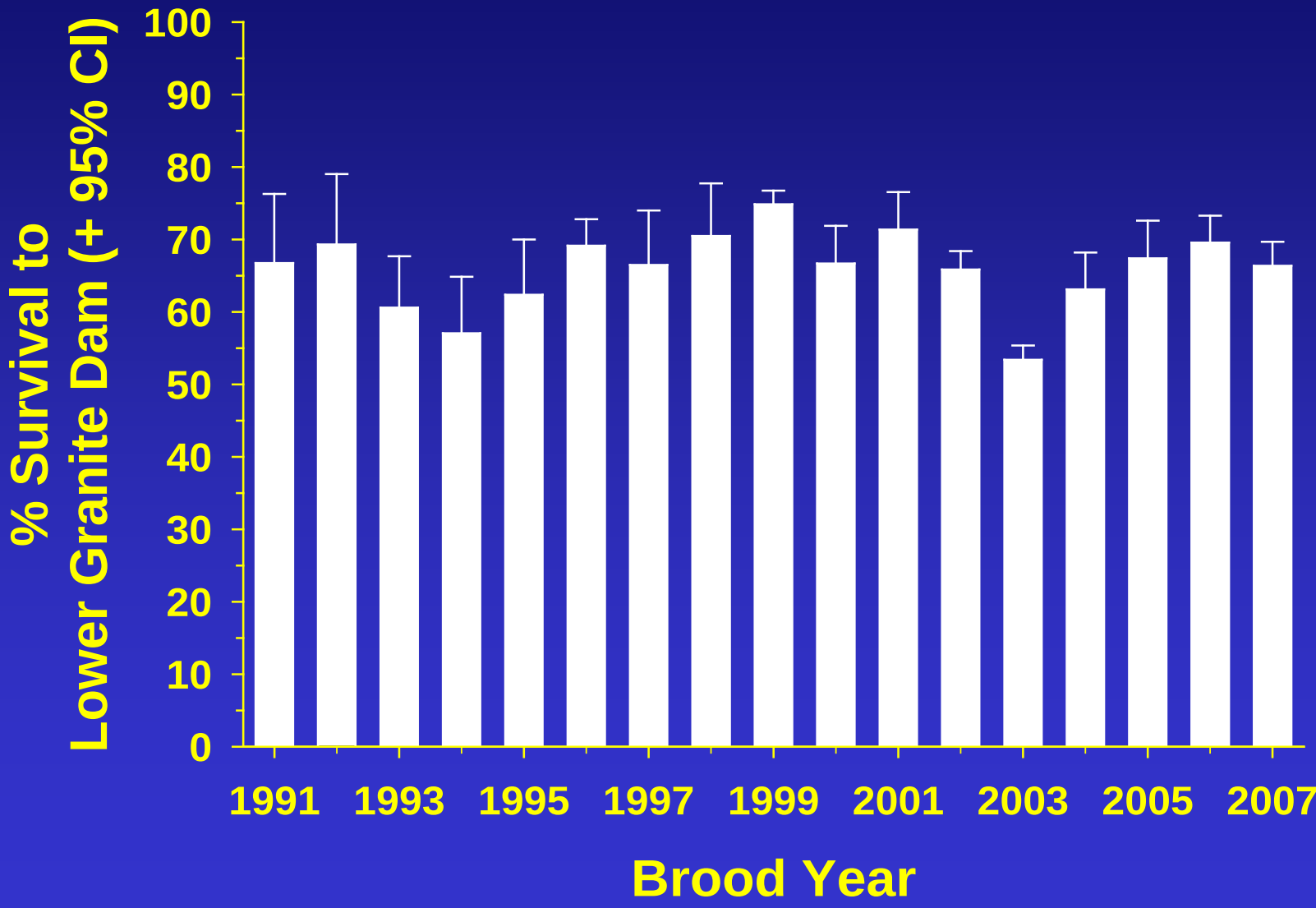
Prespawn Mortality; Green Egg-to-Smolt Survival



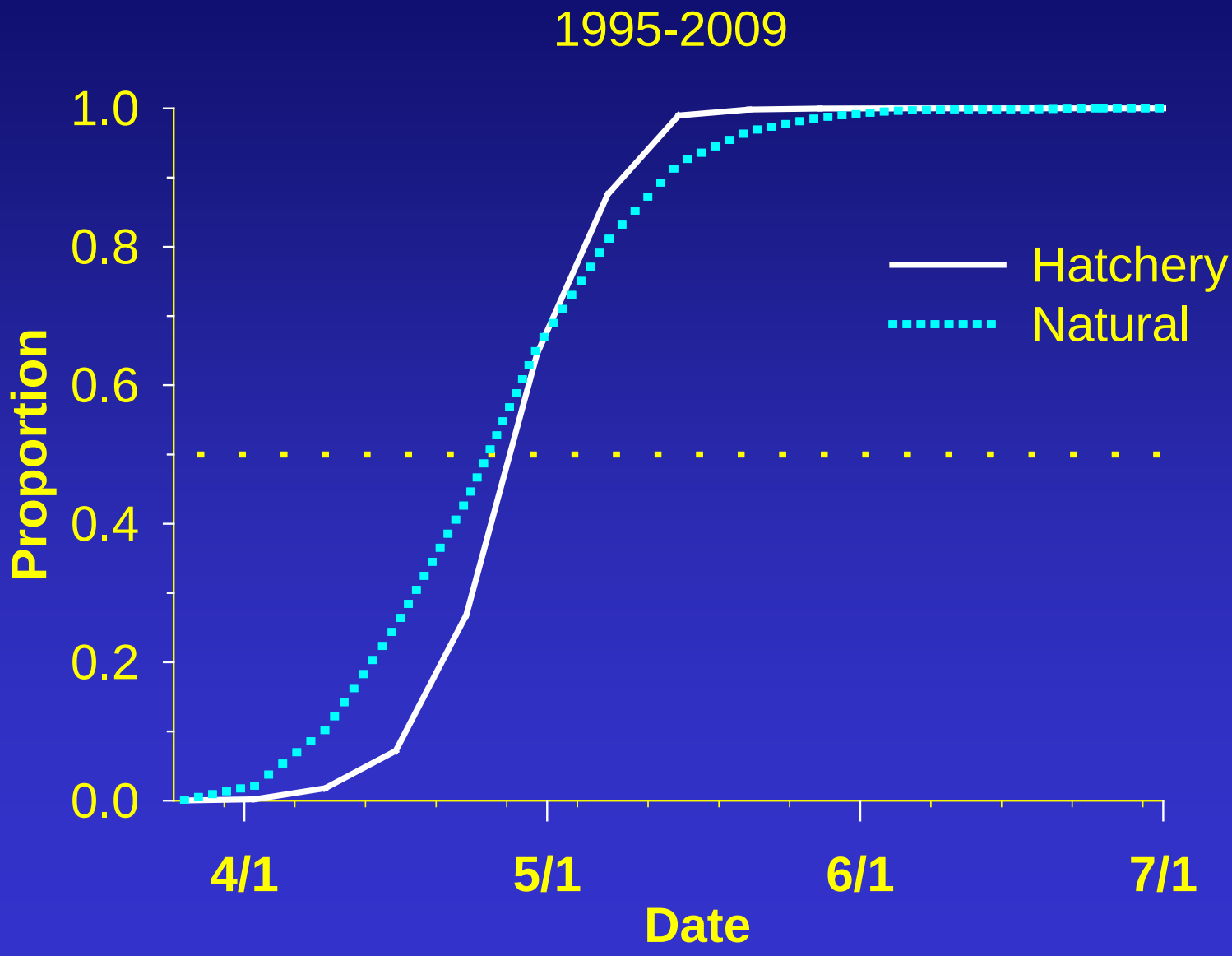
Imnaha River Hatchery Smolt Releases



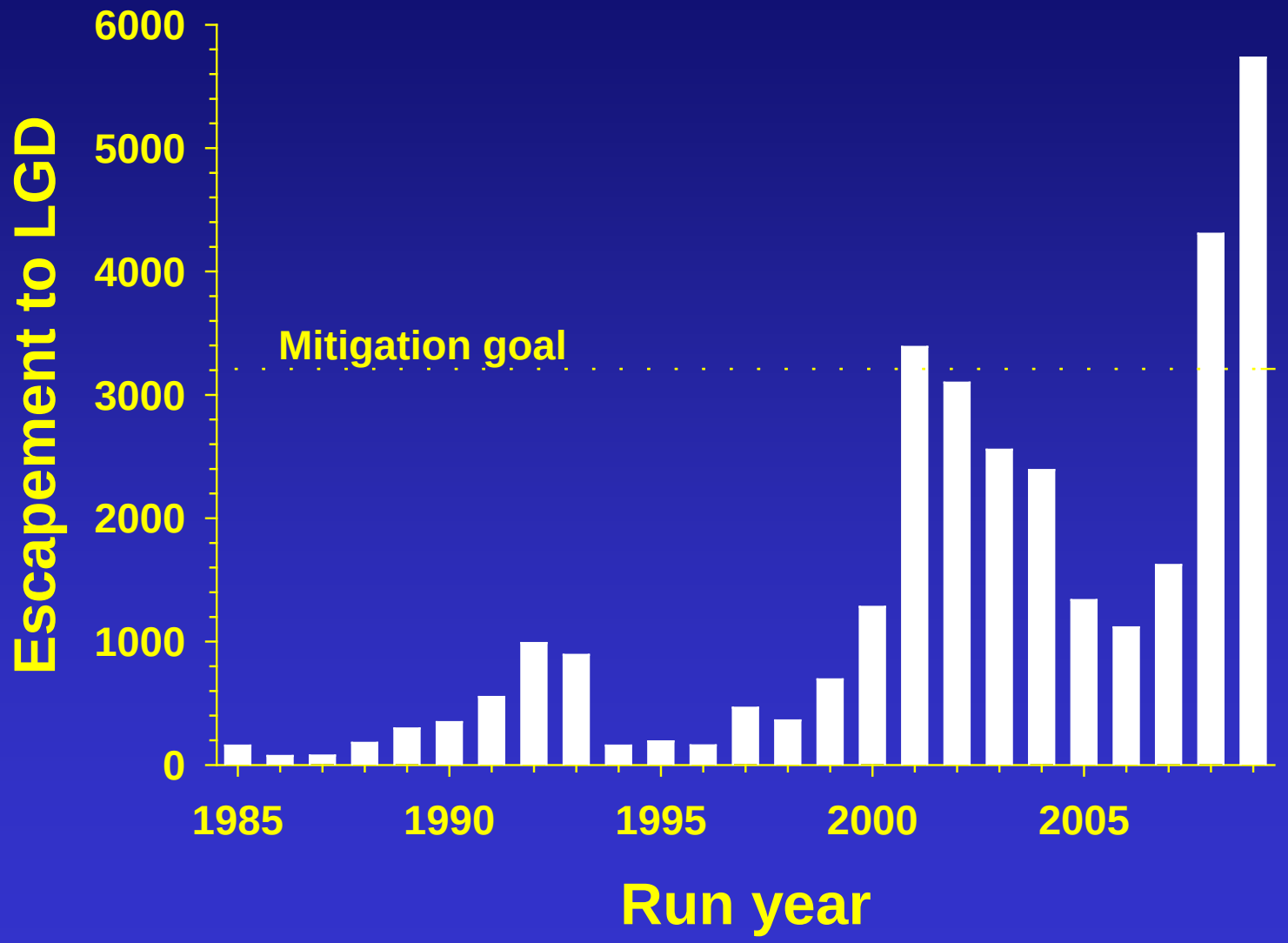
Imnaha River Hatchery Smolt Survival to Lower Granite Dam



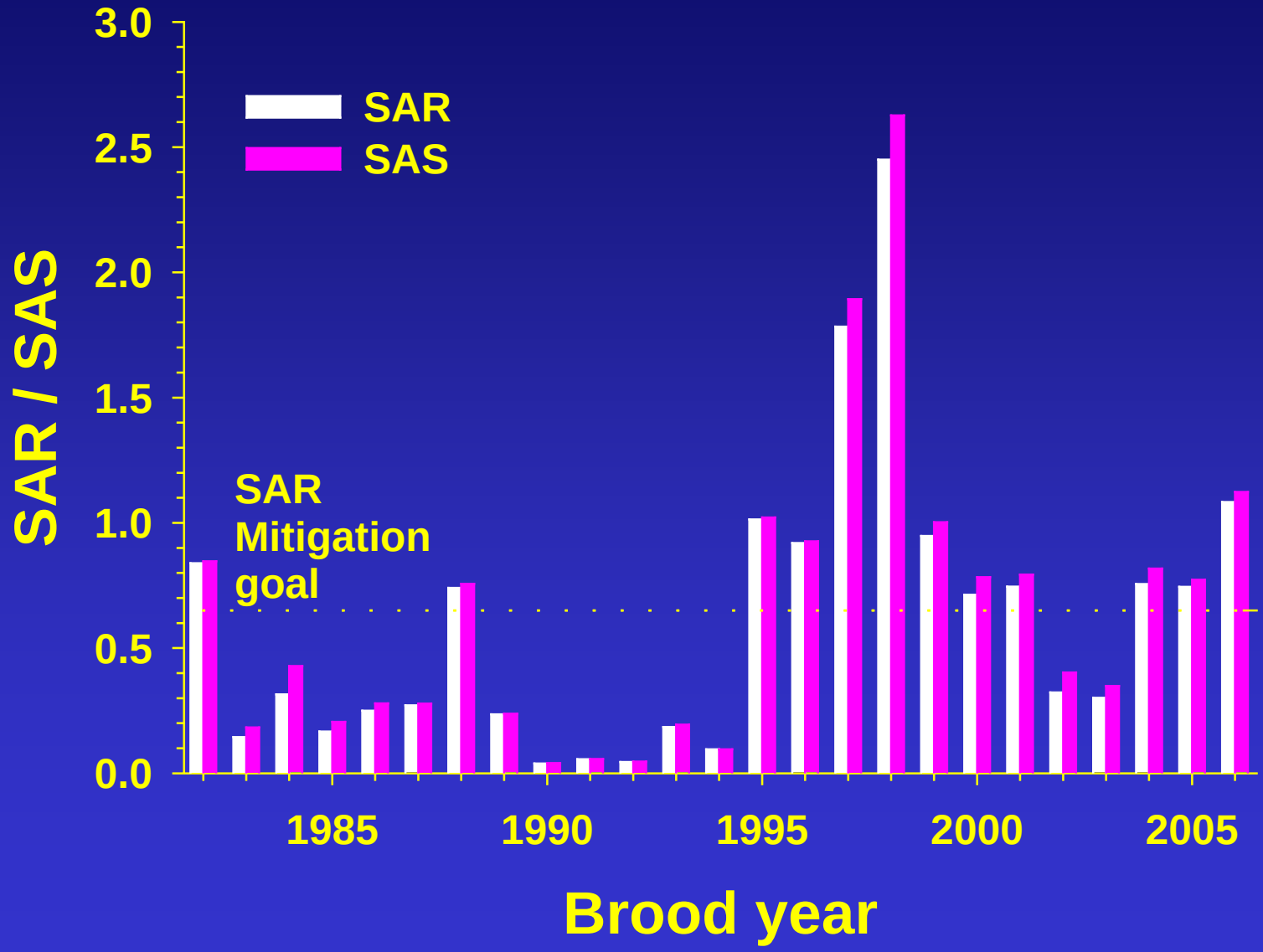
Smolt Migration Timing at Lower Granite Dam



Adult Returns to the Compensation Area



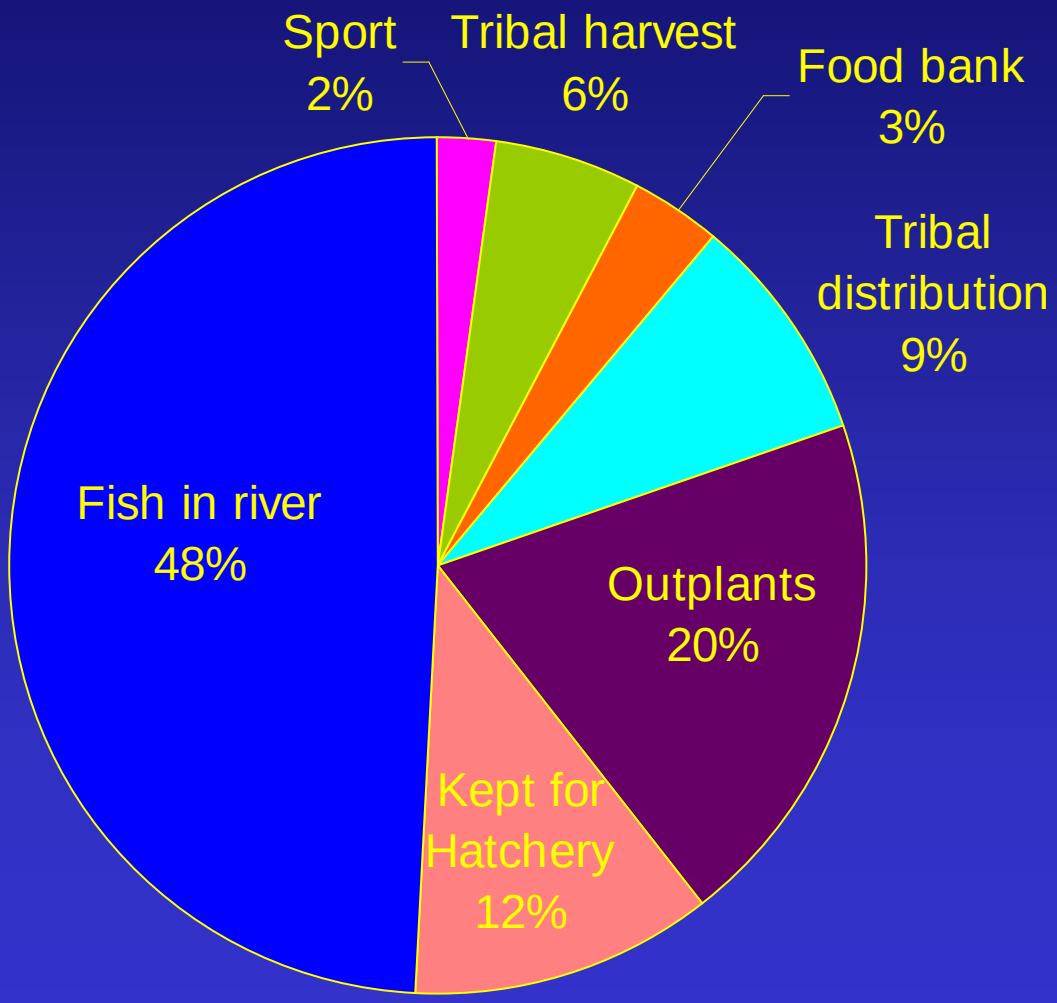
Imnaha River Chinook
Smolt-to-Adult Survival/Return Rates



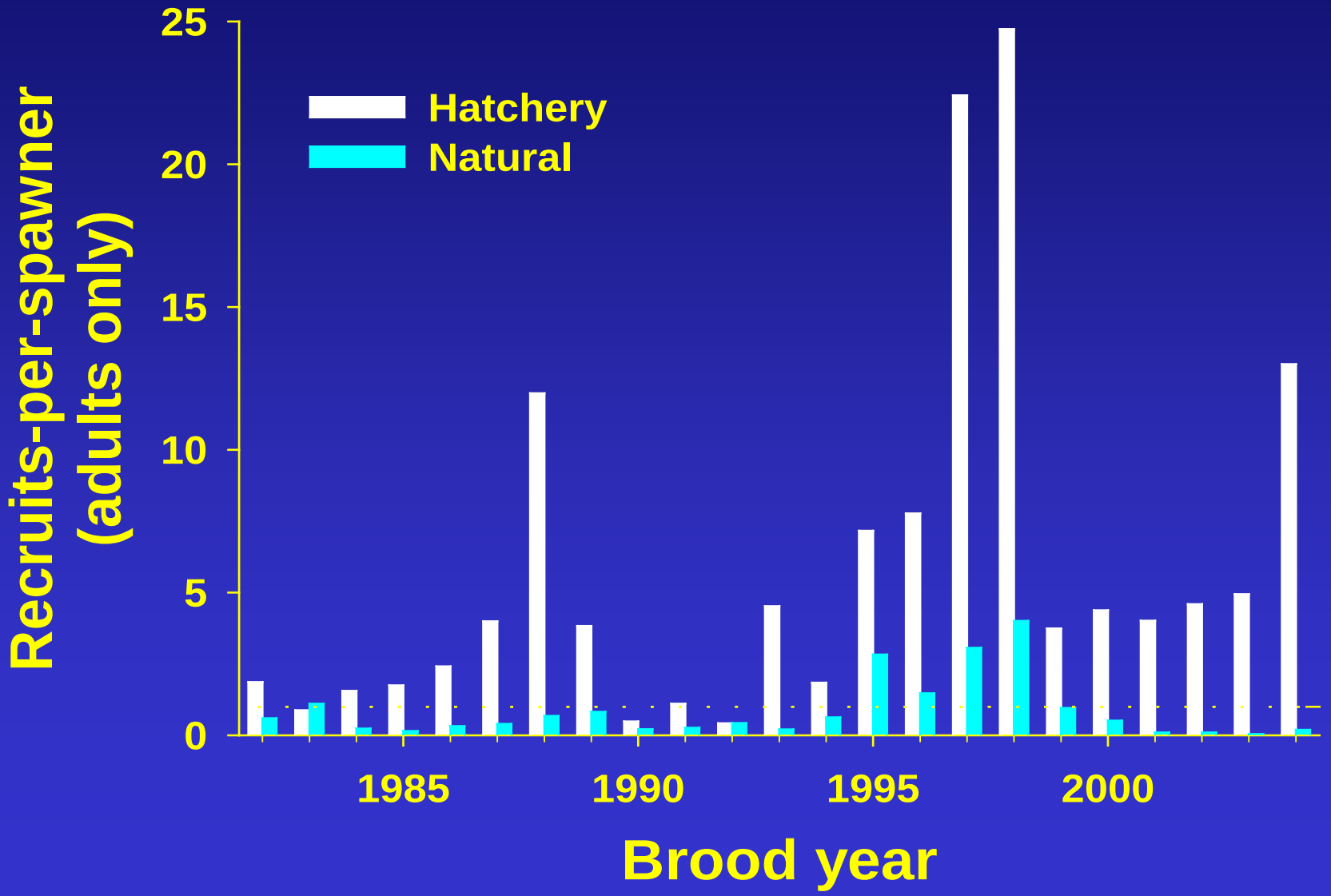
Catch and Escapement (%) of Spring Chinook Salmon Released in the Imnaha River Basin

	Brood Year				
	2001	2002	2003	2004	Mean
Ocean	0.6	0.2	0.1	0.4	0.3
Columbia River Harvest					
Tribal	1.3	3.5	7.4	1.5	3.4
Sport	3.0	12.1	4.5	4.6	6.1
Commercial net	0.8	2.0	0.6	0.3	0.9
Snake River					
Stray below LGD	0.3	0.2	0.4	0.6	0.4
Stray above LGD	0.0	0.4	0.3	0.1	0.2
Sport above LGD	0.2	1.3	0.0	0.0	0.4
Tribal above LGD	0.0	0.0	0.0	0.0	0.0
Escapement to River	**93.9**	**80.2**	**86.7**	**92.5**	**88.3**

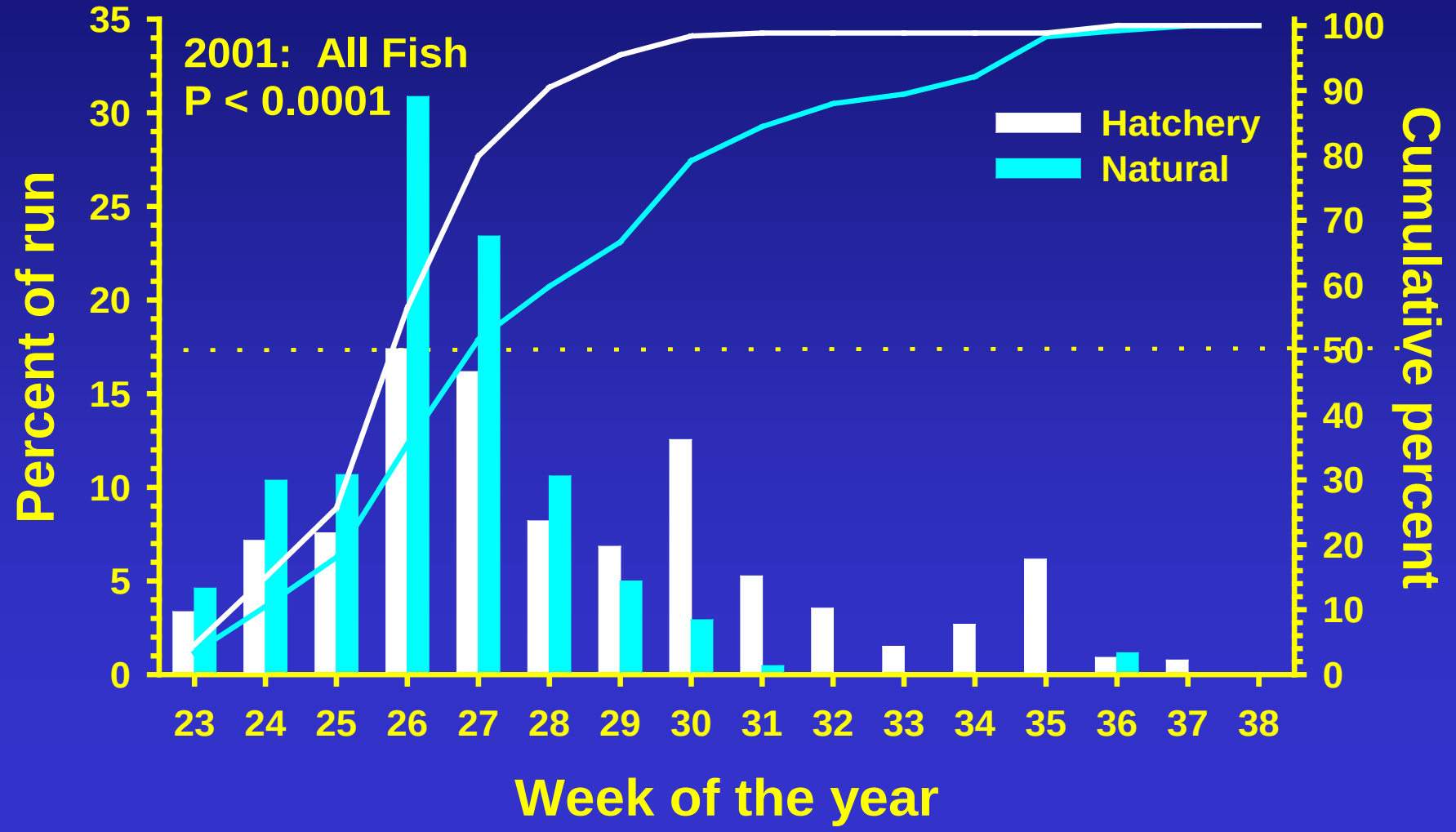
Escapement Disposition of Imnaha River Hatchery Chinook from the 2001-2004 Brood Years



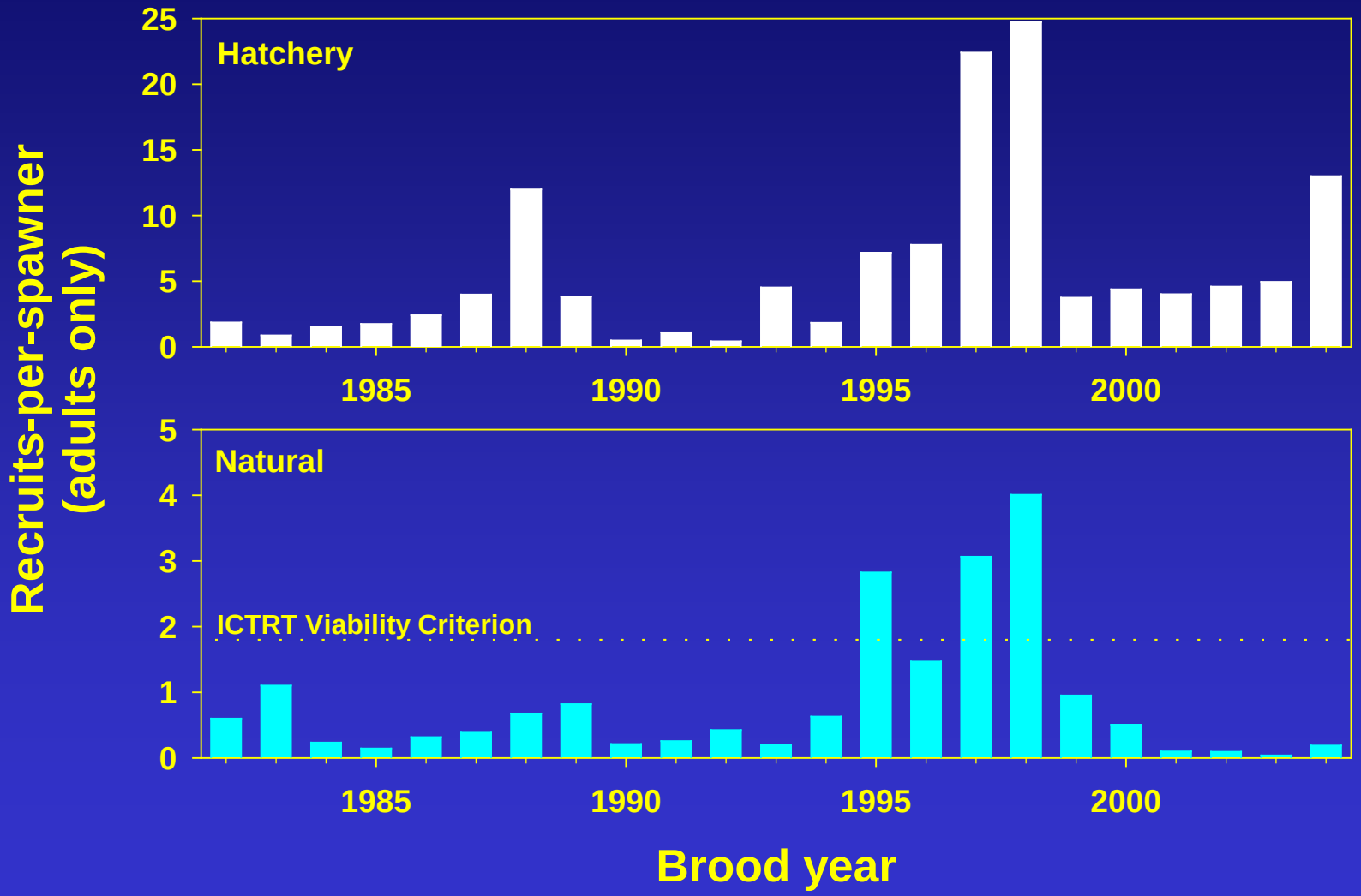
Imnaha River Adult Recruits-per-Spawner
Hatchery and Natural Origin



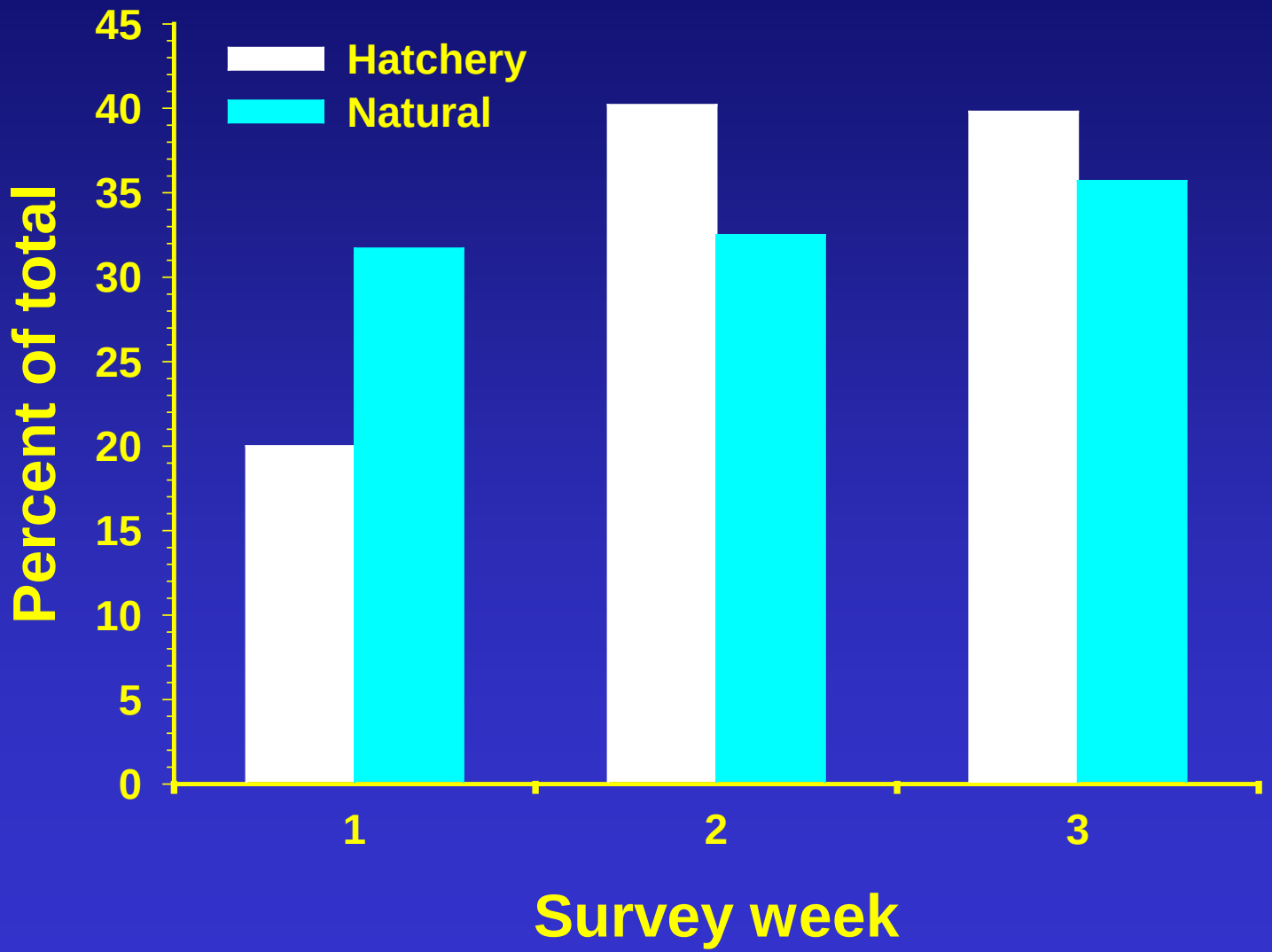
Run Timing of Hatchery and Natural Origin Imnaha River Chinook Salmon



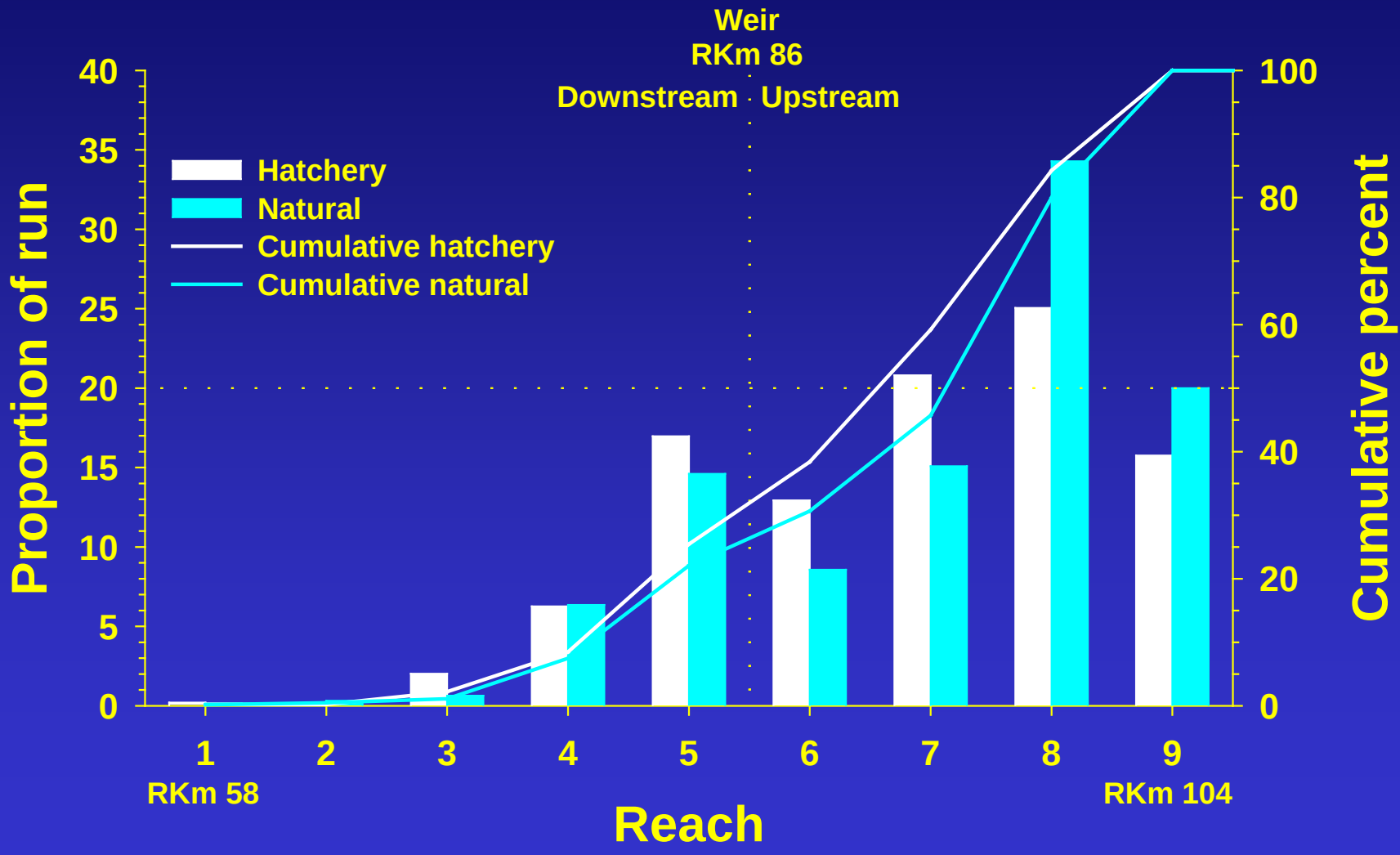
Imnaha River Adult Recruits per Spawner



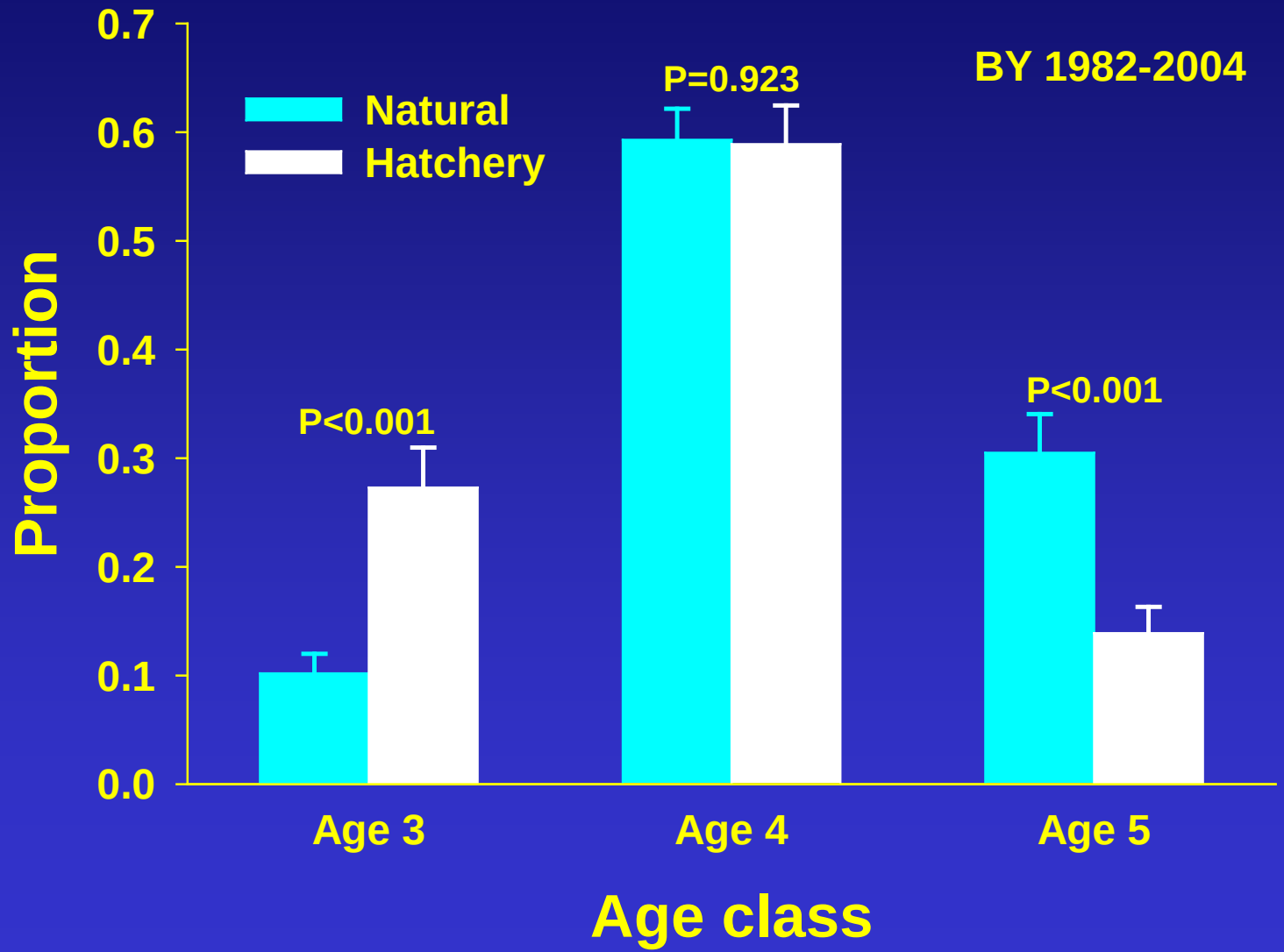
Female Spawn Timing in Nature



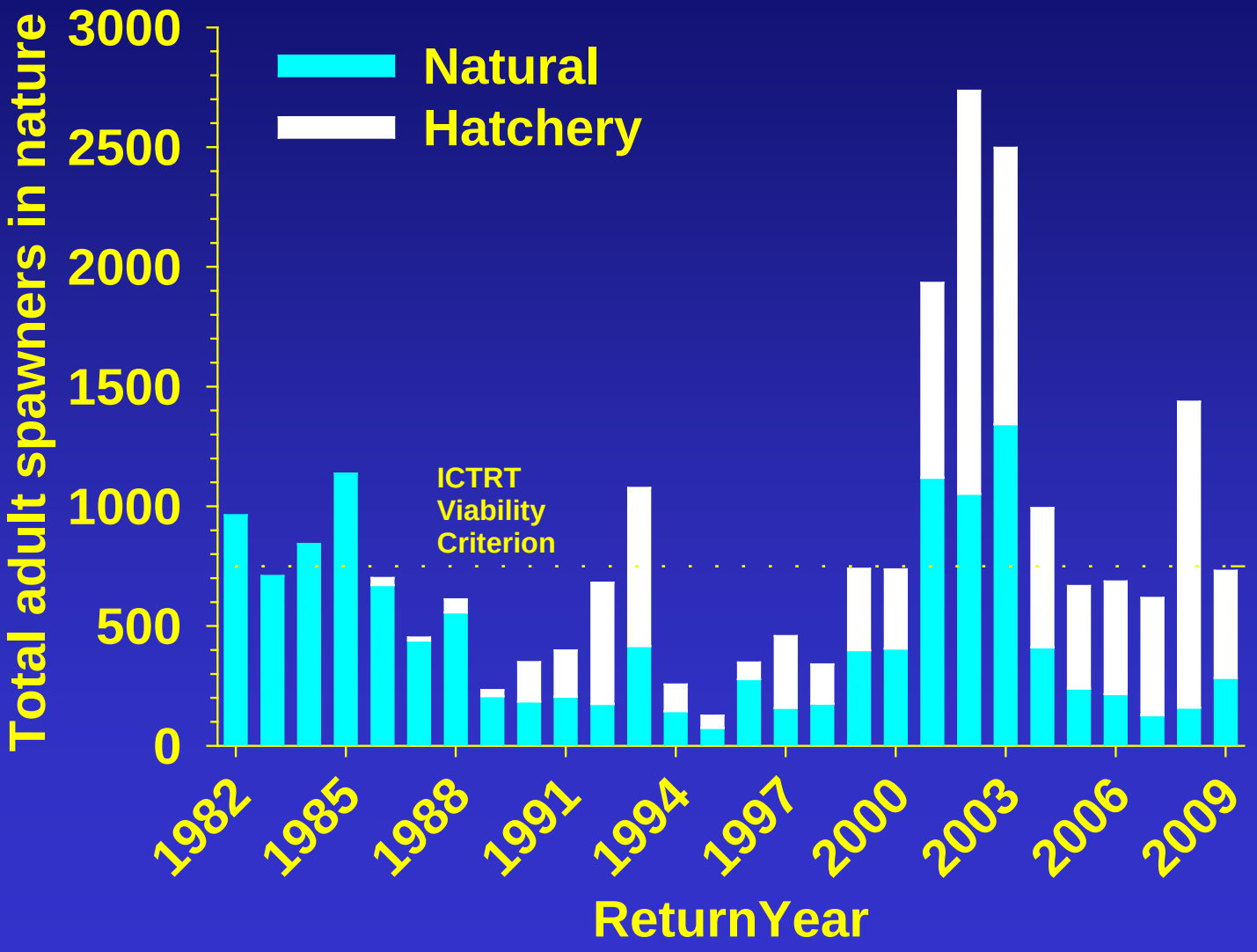
Spawning Distribution



Age at Return
Imnaha River



Imnaha River
Total Spawners in Nature



Abundance and Productivity Comparison Approach

- Compiled spawner and recruit adult abundance and productivity (R/S) time series datasets for Imnaha and unsupplemented Idaho Salmon River Chinook salmon populations (ICTRT / ODFW / IDFG).

- Determined level of correlation (Pearson's) in abundance and productivity between Idaho and Imnaha populations for the pre-supplementation time period (late 1950's-1985 for abundance and late 1950's-1981 for productivity) to evaluate adequacy as reference populations.

- Calculated and compared pre and post ratios of Imnaha-to-reference for total spawners, natural origin spawners, and productivity (year specific and means).

Abundance/Productivity Comparison Approach - Hypotheses

If the program is successfully supplementing the natural population, then:

1 - Total spawner abundance should increase.

- Therefore, the post- supplementation total abundance ratio should be higher than during the pre-supplementation period.

2 - Natural origin abundance should increase.

- Therefore, the post- supplementation natural origin abundance ratio should be higher than during the pre-supplementation period.

3 – Productivity should not change.

- Therefore, the post-supplementation productivity ratio should be equal to or higher than during the pre-supplementation period.

Abundance/Productivity Comparison Approach

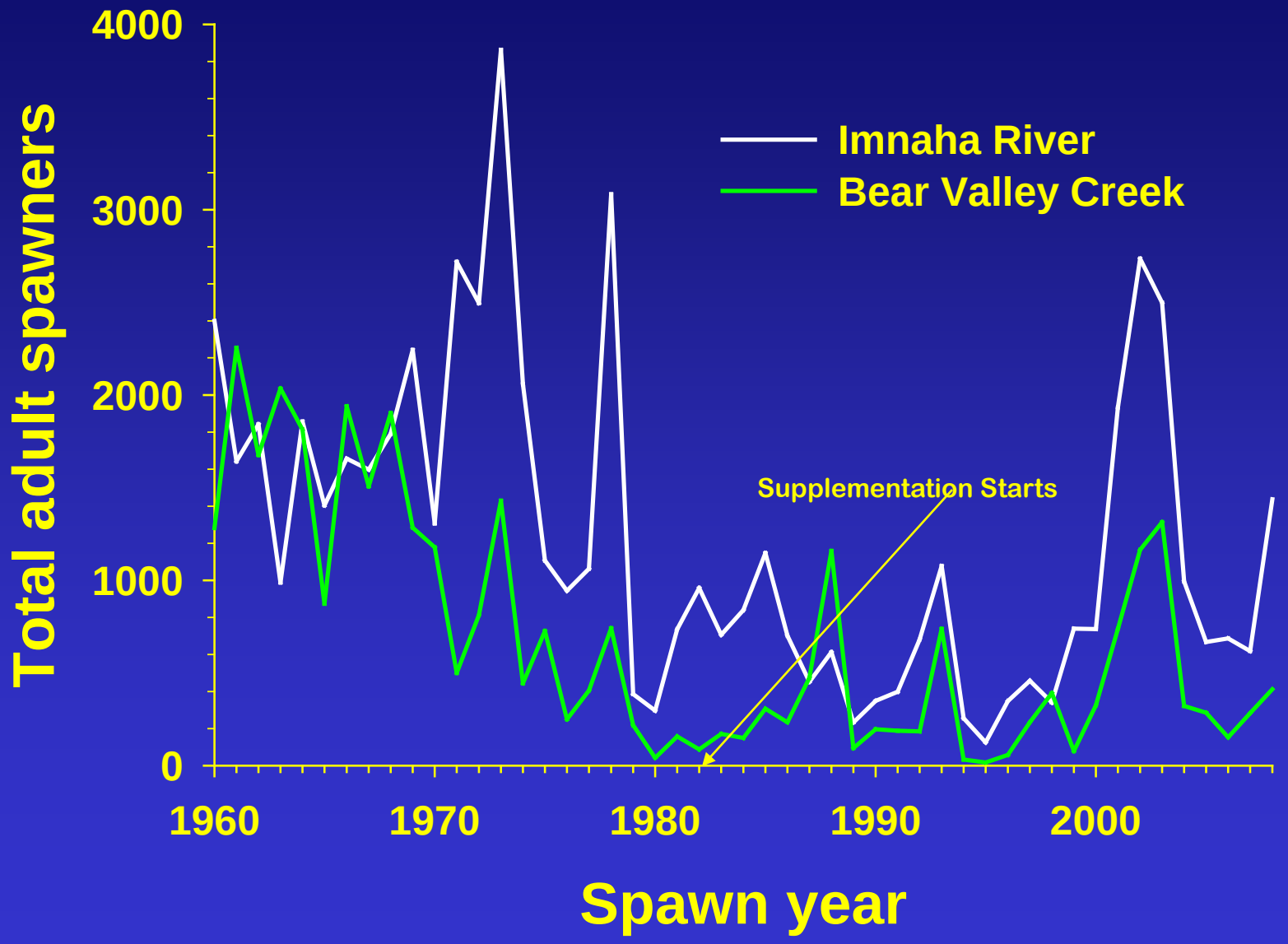
- Calculated ratios of Imnaha-to-unsupplemented (Idaho) populations for total spawner abundance, natural origin spawner abundance, and productivity (year specific and means).
  - Ratio = $\frac{\text{Imnaha River}}{\text{Unsupplemented stream}}$
    - Compared ratios between pre- and post-supplementation time periods.
  - Abundance:
    - Pre-supplementation: late 1950s – 1985 return years
    - Post-supplementation: 1986-2004 return years
  - Productivity:
    - Pre-supplementation: late 1950s – 1981 brood years
    - Post-supplementation: 1986 – 1999 brood years

Abundance/Productivity Comparison Populations

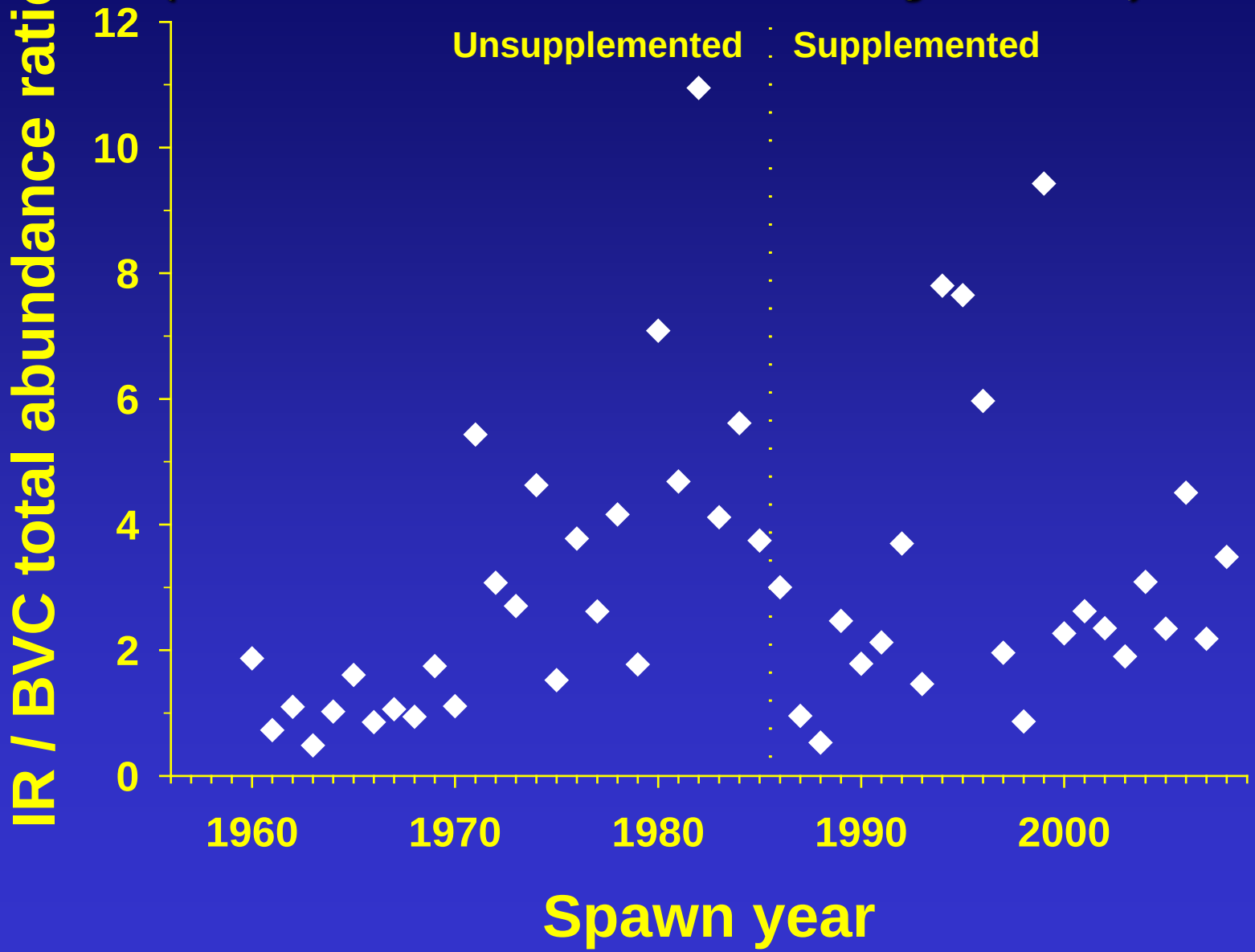
Pre-Supplementation Natural-Origin Abundance Correlations
Imnaha Population vs. Idaho Populations

	Natural origin abundance		Recruits per spawner	
Idaho stream	rho	P-value	rho	P-value
Bear Valley Creek	0.56501	0.0026	0.47290	0.0262
Big Creek	0.53876	0.0026	0.36653	0.0715
Camas Creek	0.67431	0.0004	0.65674	0.0023
Lemhi River	0.47824	0.0087	0.40587	0.0441
Loon Creek	0.64394	0.0002	0.60903	0.0016
Marsh Creek	0.62440	0.0003	0.53570	0.0058
Sulphur Creek	0.52331	0.0043	0.35625	0.0805
Valley Creek	0.75378	<0.0001	0.58447	0.0027

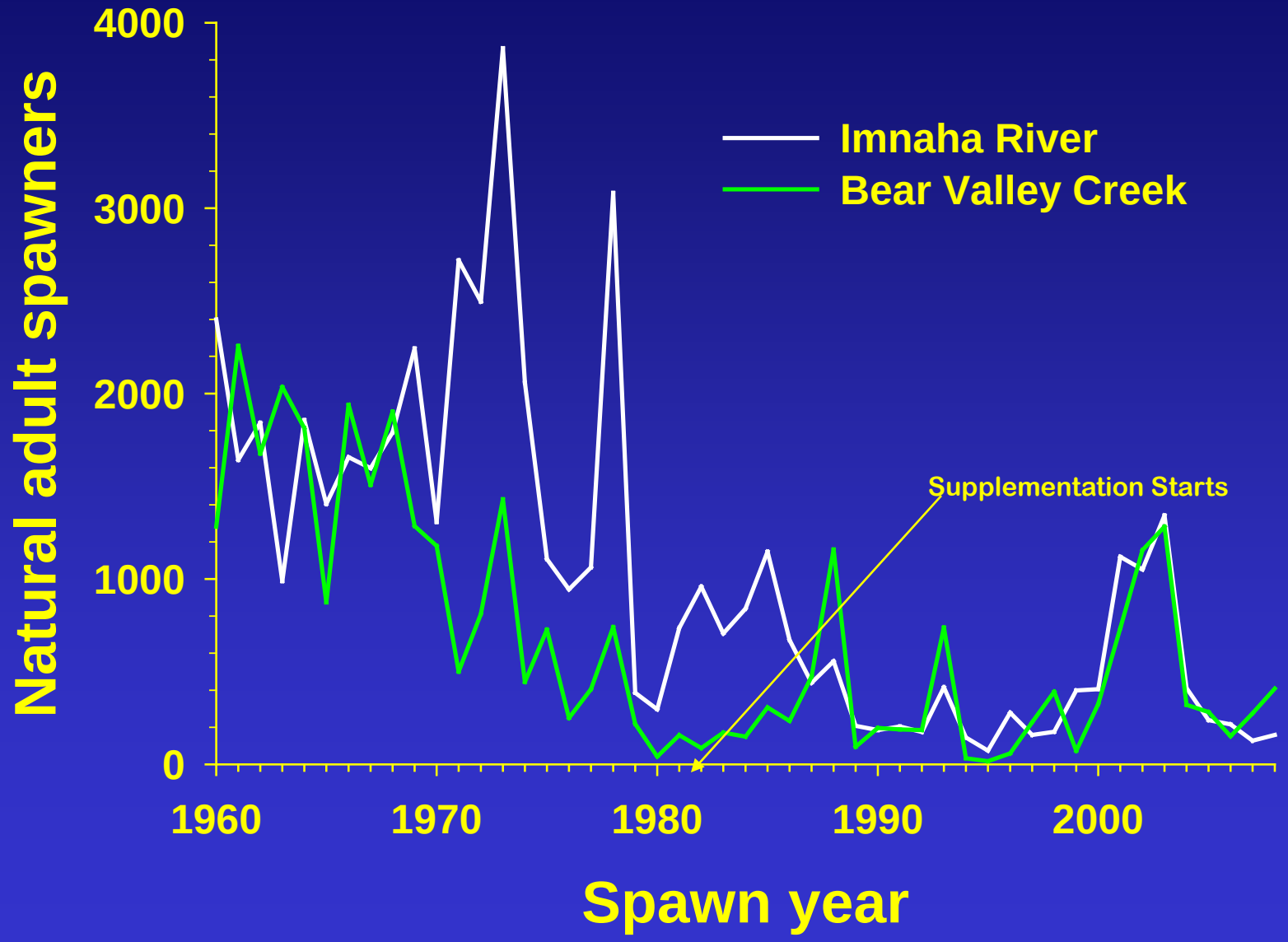
Abundance of Total Spawners



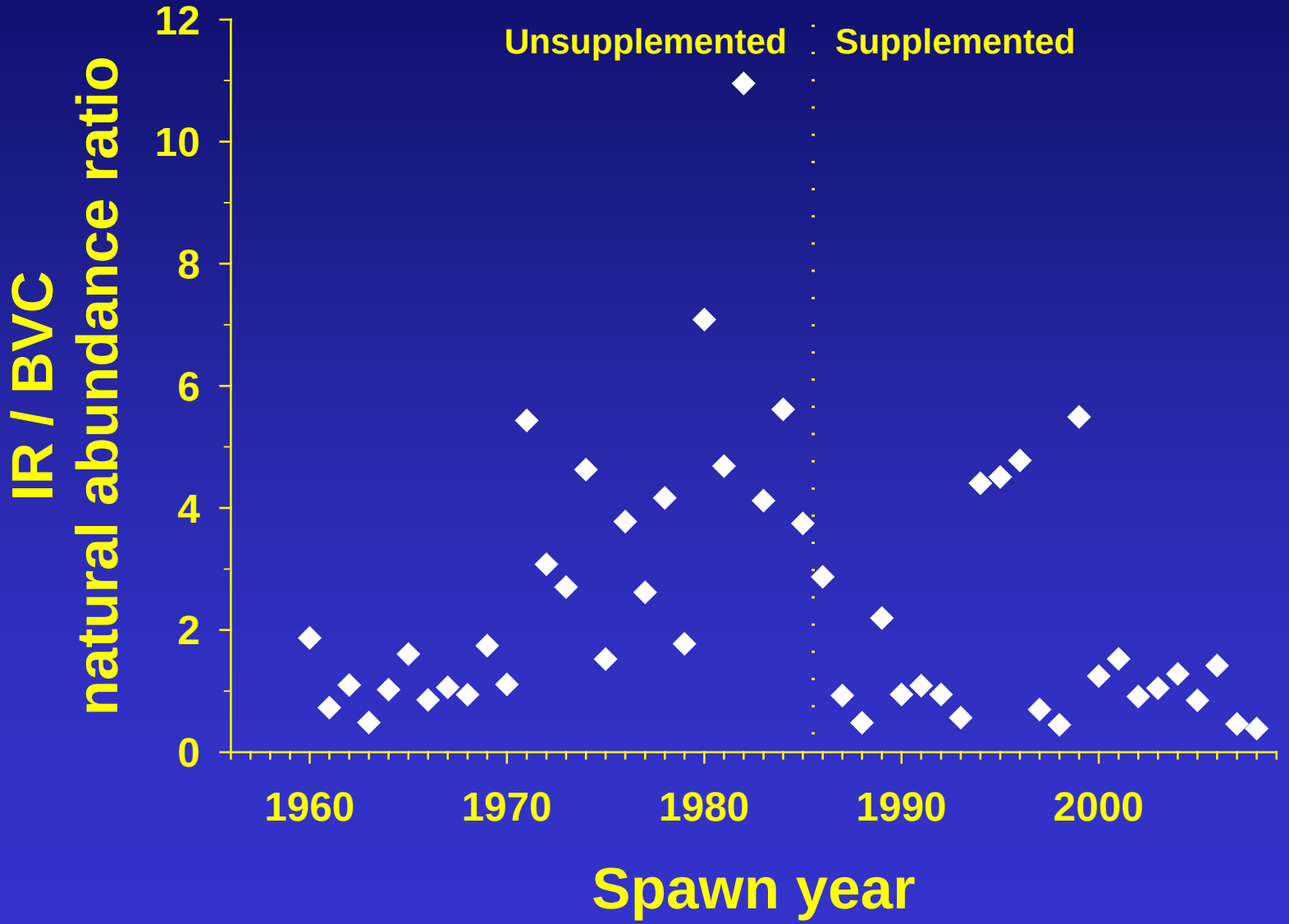
Total Abundance Ratio (Imnaha River / Bear Valley Creek)



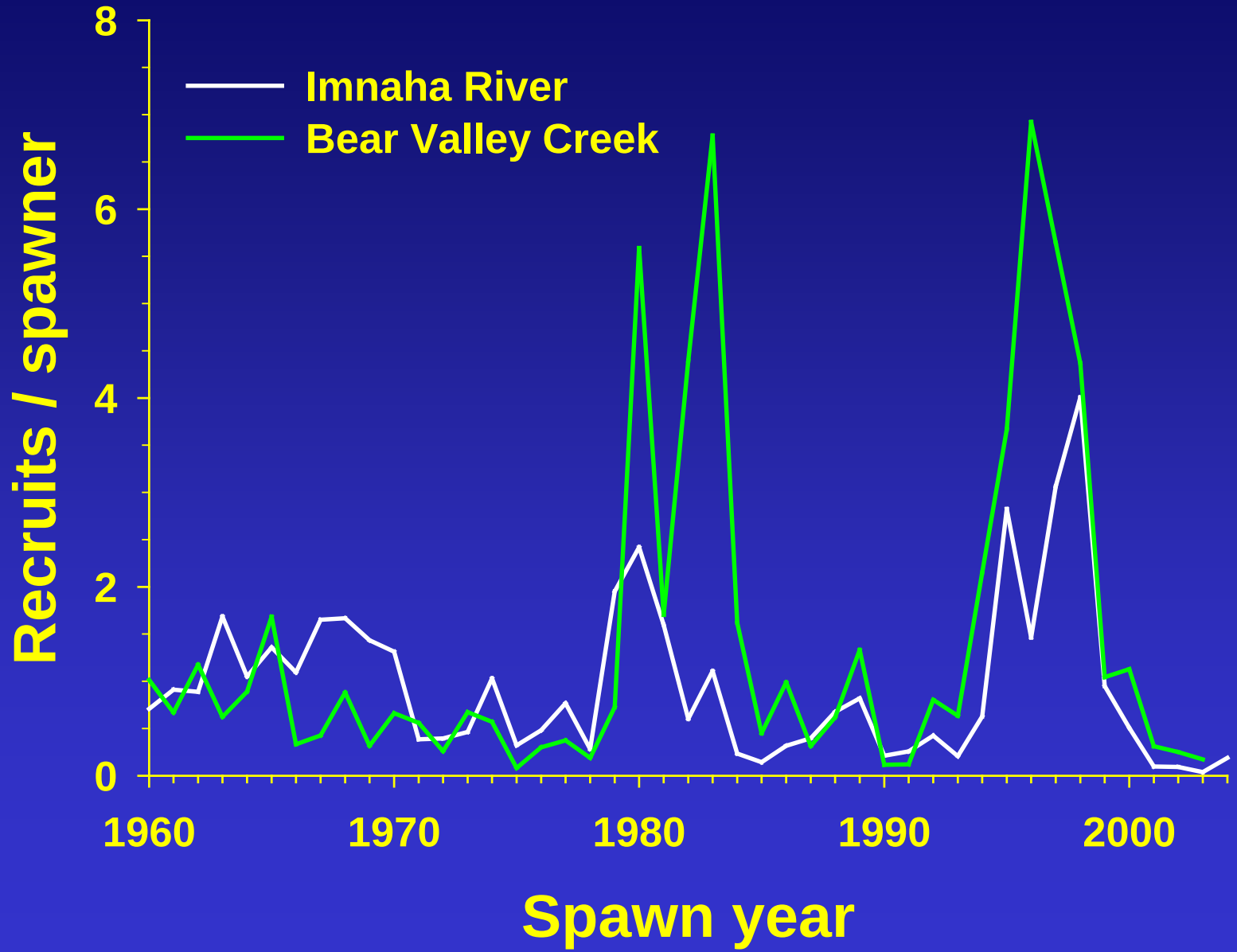
Abundance of Natural Origin Spawners



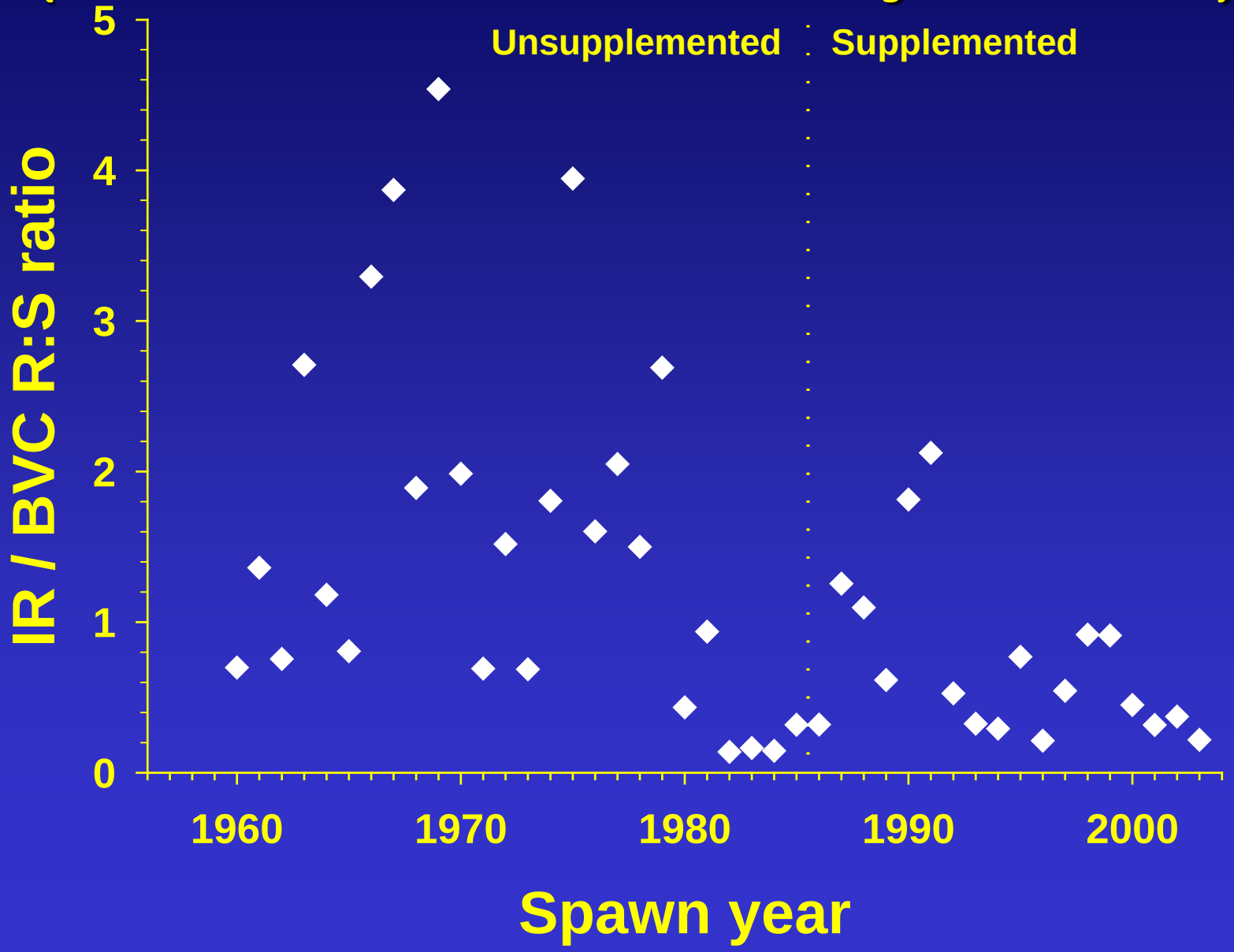
Natural-Origin Abundance Ratio (Imnaha River / Bear Valley Creek)



Recruits:Spawner Ratio



Recruits per Spawner Ratio (Imnaha River R:S / Bear Valley Creek R:S)



Total Spawner Abundance Ratios (Imnaha Abundance / Unsupplemented Abundance)

Stream	Mean Pre-supplementation	Mean Post-supplementation	Difference		P-value (t-test)
Bear Valley Creek	3.02	3.24	0.22	↑	0.568
Big Creek	7.54	9.89	2.35	↑	0.796
Camas Creek	10.18	27.76	17.58	↑	0.007
Lemhi River	2.84	10.84	8.01	↑	<0.001
Loon Creek	14.23	29.17	14.94	↑	0.065
Marsh Creek	3.77	5.80	2.03	↑	0.146
Sulphur Creek	10.92	21.05	10.13	↑	0.096
Valley Creek	13.74	16.65	2.90	↑	0.002

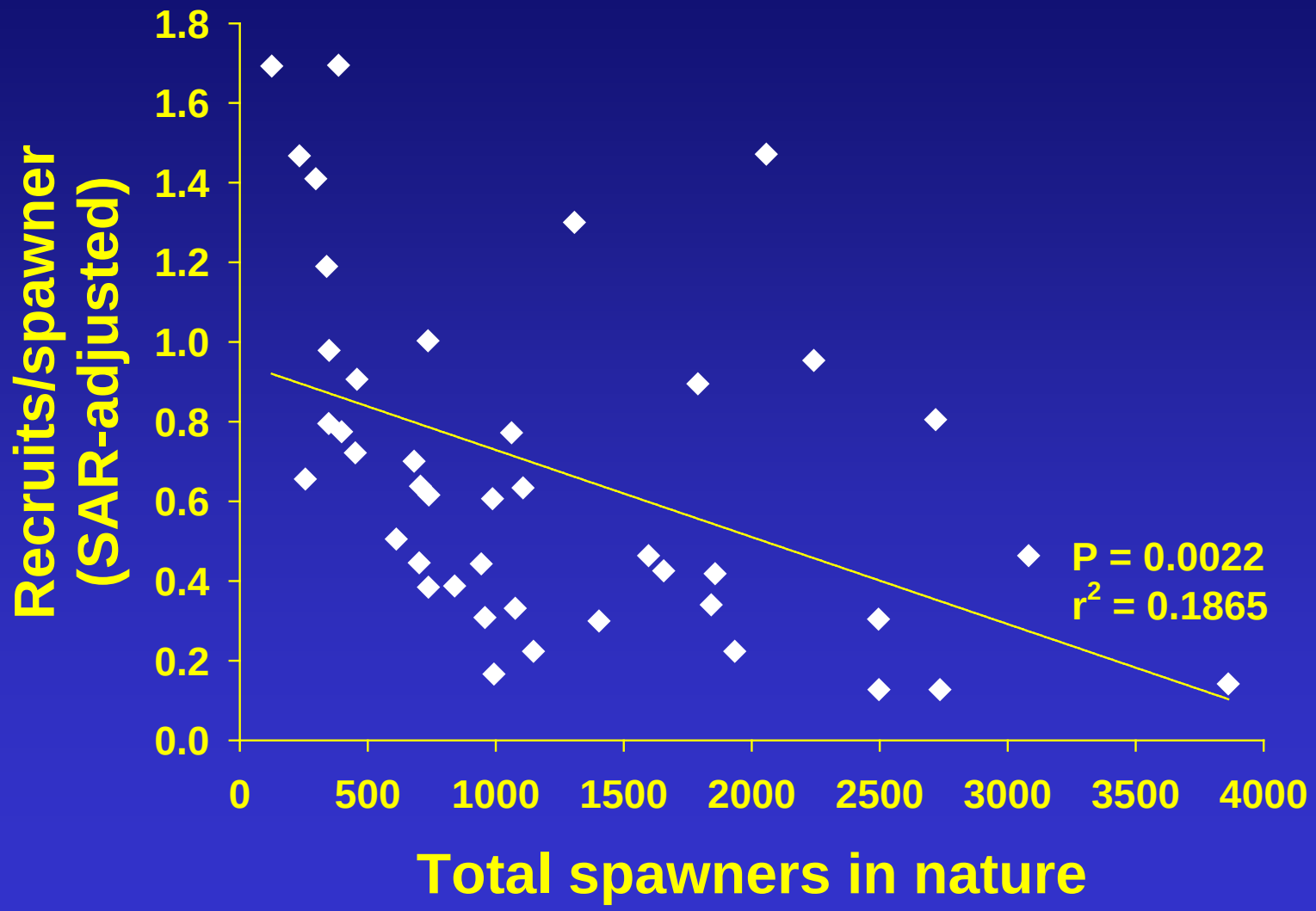
Natural Origin Spawner Abundance Ratios (Imnaha Abundance / Unsupplemented Abundance)

Stream	Mean Pre-supplementation	Mean Post-supplementation	Difference		P-value (t-test)
Bear Valley Creek	3.02	1.72	-1.30	↓	0.013
Big Creek	7.54	5.68	-1.85	↓	0.006
Camas Creek	10.18	16.08	5.90	↑	0.783
Lemhi River	2.84	4.49	1.65	↑	0.019
Loon Creek	14.24	16.66	2.42	↑	0.437
Marsh Creek	3.77	2.84	-0.93	↓	0.049
Sulphur Creek	10.92	9.79	-1.13	↓	0.337
Valley Creek	13.74	8.45	-5.29	↓	0.318

Recruit per Spawner Ratios (Imnaha R:S / Unsupplemented R:S)

Stream	Mean: Pre-supplementation	Mean: Post-supplementation	Difference		P-value (t-test)
Bear Valley Creek	1.86	0.63	-1.23	↓	<0.001
Big Creek	1.71	0.81	-0.90	↓	0.012
Camas Creek	1.94	1.48	-0.45	↓	0.062
Lemhi River	1.72	1.04	-0.68	↓	0.005
Loon Creek	2.32	1.44	-0.87	↓	0.002
Marsh Creek	1.56	1.15	-0.41	↓	0.026
Sulphur Creek	2.13	1.54	-0.59	↓	0.031
Valley Creek	1.66	0.85	-0.81	↓	<0.001

Imnaha River



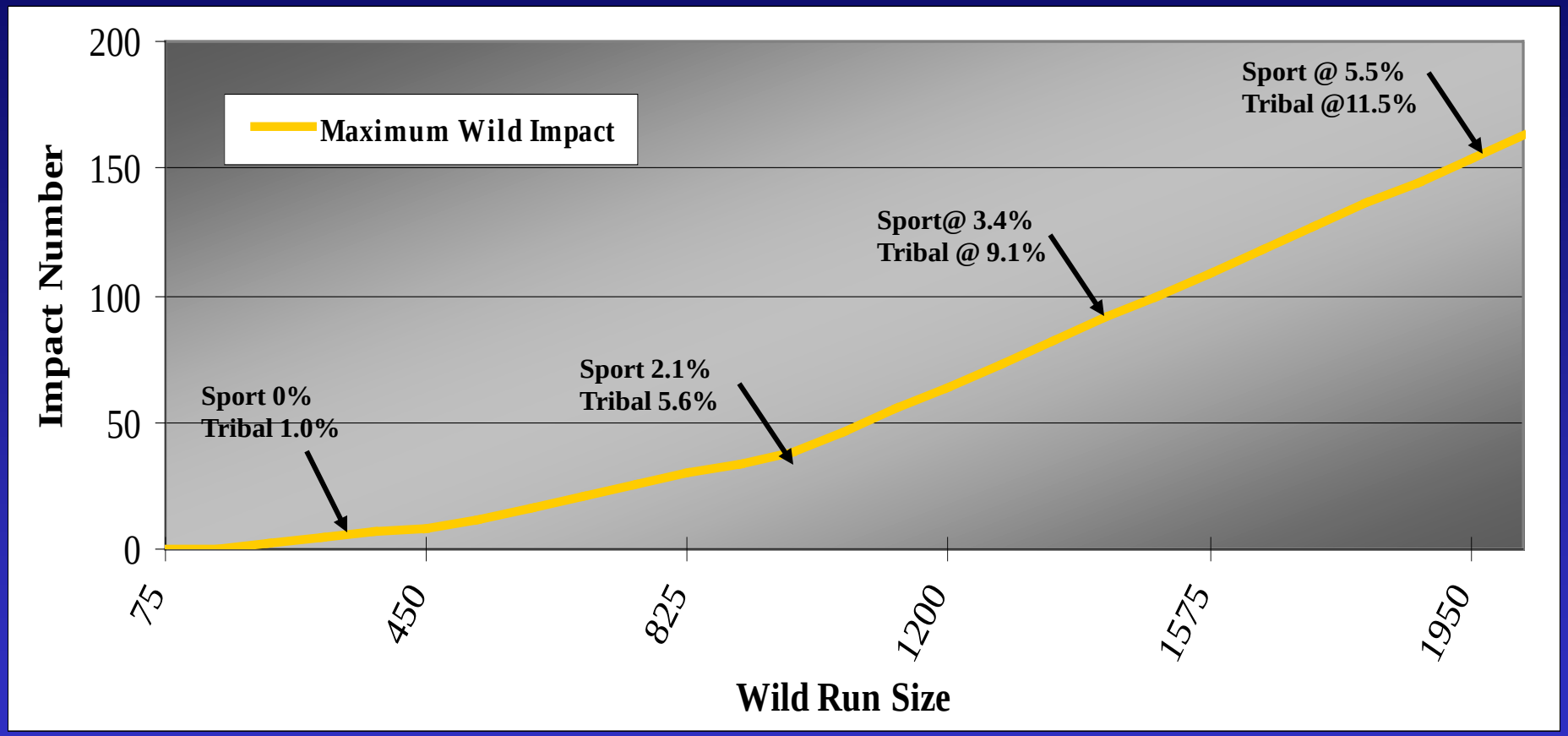
Tributary Harvest Management Strategy

- Allowable natural origin impact is conservative and scaled relative to “critical and viable levels”.
- Each population is considered separately in fishery decisions.
- Fishery protects any population below “critical” threshold from impact.
- Generally hatchery fish harvest limited by resulting incidental impact on natural origin adults.
- Hatchery fish escapement must meet broodstock and supplementation needs.
- Monitoring allows impact tracking and in-season adjustment.

List of Natural Grande Ronde Spring Chinook Population Units and Associated Interim "Viable Salmonid Thresholds"

Natural Population Units	Critical Thresholds Abundance	Viable Thresholds Abundance
Wallowa/ Lostine Rivers	225 adults/yr	750 adults/yr
Catherine Creek	150 adults/yr	500 adults/yr
Upper Grande Ronde River	150 adults/yr	500 adults/yr
Imnaha River	300 adults/yr	1000 adults/yr
Wenaha River	225 adults/yr	750 adults/yr
Minam River	225 adults/yr	750 adults/yr

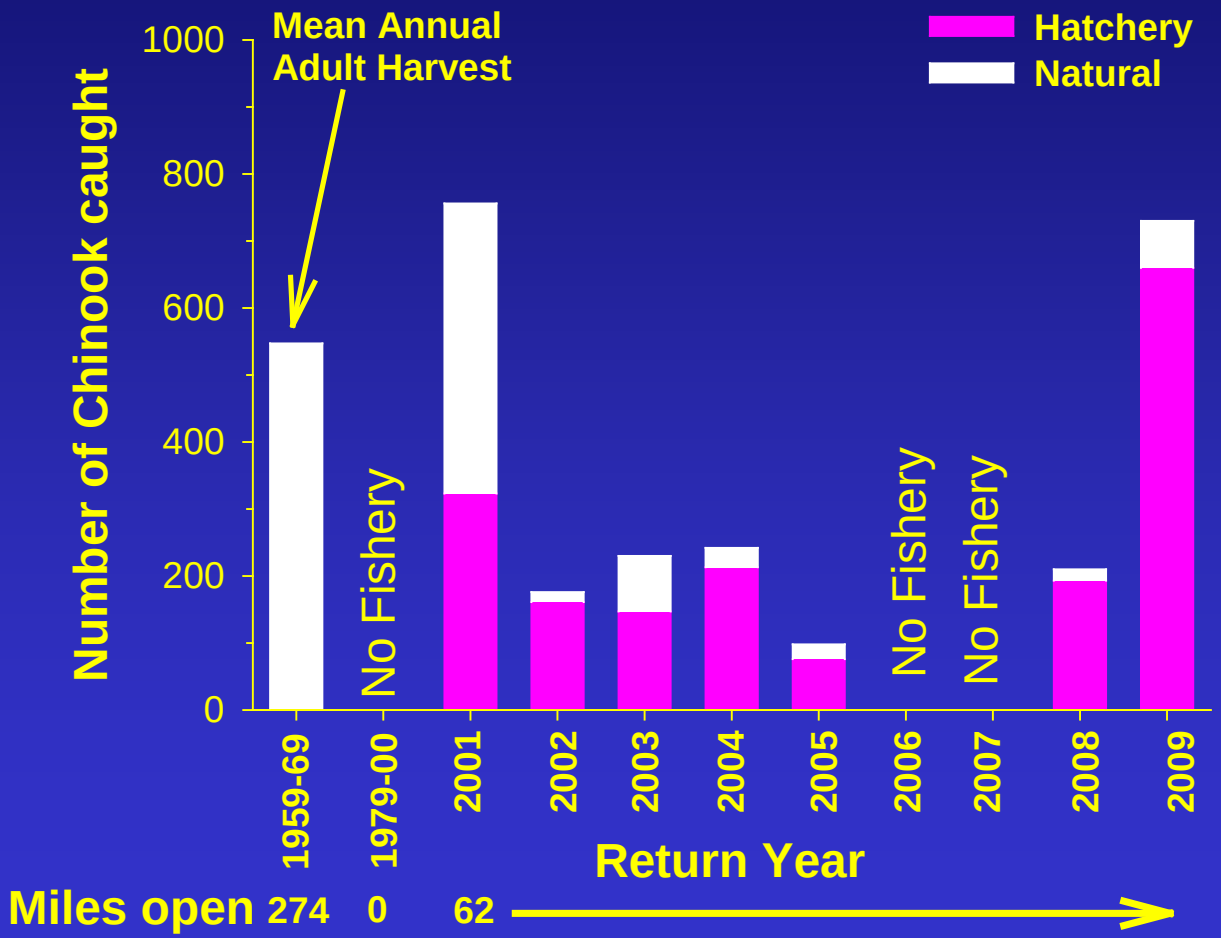
Natural Origin Sport Fishery Impact



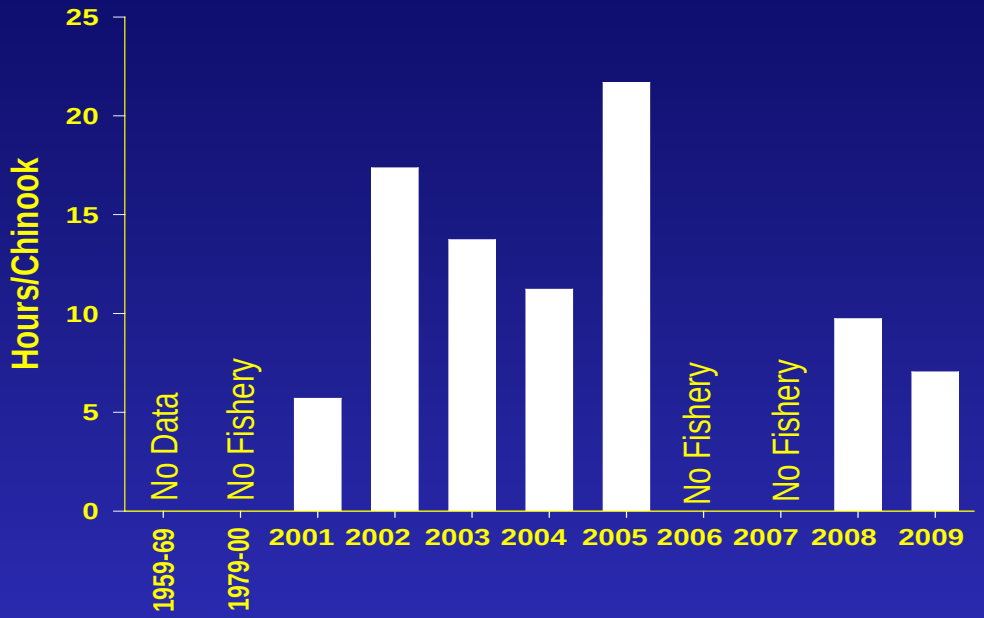
Proposed maximum allowable natural origin sport fishery impact at various run sizes for Imnaha River

Imnaha Recreational Fishery

Hatchery fish harvested; natural fish released



Imnaha Recreational Fishery Catch Index



Imnaha River Program Performance Summary

- **Broodstock Development – Management:**
  - Limited availability of natural adults for broodstock
  - Substantial proportion of run escapes weir in most years
  - Low PNI's

- **In-Hatchery Performance:**
  - Egg-to-smolt survival variable, high in most years
  - Adult prespawn mortality variable, low in most years

- **Hatchery Program Performance:**
  - Interim smolt goals reached in most years
  - Higher end of smolt survival to Lower Granite for hatchery stocks
  - Adult return goals reached in four of recent 10 years
  - SAR's consistently at goal (80% of last 10 years)
  - Low catch to escapement ratio with low exploitation in lower Columbia fisheries
  - Low stray rates
  - Recreational fishery in seven of last ten years, shorter seasons, lower harvest than historical

Program Performance Summary

Supplementation : Life History and Spawning Characteristics

- Hatchery fish return at an earlier age.
- Hatchery fish return and spawn at a later date.
- Spawner distribution of hatchery females is more downstream than natural females and near the release location, range is the same.
- Size-at-age and age specific fecundity are equal, mean fecundity of hatchery females is lower.

Program Performance Summary
Supplementation : Abundance and Productivity

- We have achieved a significant life cycle survival advantage for hatchery salmon with a recruit per spawner advantage of 10:1.
- We have not observed a trend of increased number of natural-origin spawners through time since supplementation started.
- Recruits per spawner for naturally spawning hatchery and natural salmon have averaged less than 1 and have been above replacement for only 5 of the last 20 brood years.
- It does not appear that we have increased natural origin abundance with supplementation even though we have increased the total number of spawners.
- Productivity of natural spawners in the Imnaha population has decreased since supplementation was initiated.

Why Not More Natural Origin Salmon and Why Does Productivity Appear Depressed?

Some Hypotheses:

- Poor reproductive success of hatchery salmon?
  - Likely given the relatively low PNI, selective broodstock collection, and resulting life history effects (spawn timing and younger age)

- Competitive and other ecological effects on natural origin juveniles?
  - Highly uncertain due to lack of information, however the number of hatchery produced smolts far exceeds natural smolt production

- Other genetic and ecological effects?
  - Likely, given selective broodstock collection, high proportion of hatchery origin salmon spawning naturally, differences in spawn timing and spawning distribution of natural and hatchery origin salmon, unnaturally high proportions of jacks spawning in nature, and potential weir effects on adult spawning distribution

- Density dependent effects of increased total spawners?
  - Likely some influence, however most post-supplementation years were low spawner abundance (1986-2000) in the Imnaha River.

Imnaha River HSRG and HRT Recommendations

- **Program Goals: HSRG – Maintain current interim 360,000 smolt goal, divide program into integrated conservation and stepping stone harvest and improve PNI:**
  HRT – Maintain current 350,000 smolt goal, modify sliding scale so that pHOS does not exceed pNOB to improve PNI and establish natural origin escapement goal where pHOS is 0.

  Response: Maintain current 360,000 smolt goal and improve PNI, however construction and operation of new weir is essential to achieve these recommendations.

- **Facility Rearing Capacities: HSRG – Improve the weir so it can trap across the run**
  HRT – Expand early rearing and smolt rearing capacities by modification of Lookingglass or construction of Lostine NEOH facility, install new more efficient weir:

  Response: New weir currently planned for implementation when funds secured other new facilities planned by co-managers

- **Rearing-Release Strategies: HSRG – Increase smolt size at release**

  Response : Not considered beneficial for survival or age-at-return

- **Define More Specific Goals for Big Sheep Creek: HRT - Co-managers establish quantifiable and measurable goals for outplanting hatchery-origin Chinook adults into Big Sheep Creek:**

  Response: Co-managers currently considering this recommendation, with expansion of monitoring under NEOH additional assessment of outplanting effectiveness will be possible

Imnaha River Hatchery Chinook Program Challenges

- New weir to collect adults across the run
  - Improve PNI
  - Improve similarity in run timing and spawn timing
- Low productivity of natural spawners and low abundance of natural origin returns
  - Limits ability to improve PNI
  - Limits ability to harvest surplus hatchery fish
- Better understanding the factors influencing the productivity of hatchery and natural fish spawning in nature